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

Next Generation Networks – Frameworks and functional architecture models

Distributed service networking service routing

Recommendation ITU-T Y.2085

International Telecommunication Union

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Recommendation ITU-T Y.2085

Distributed service networking service routing

Summary

Recommendation ITU-T Y.2085 specifies the architecture for service routing functions (SRF). Service routing supports the service registration, discovery, and triggering and access mechanisms in the environment of distributed service networking (DSN) as described in Recommendation ITU-T Y.2080.

The main objectives of this Recommendation are to specify:

– Functional entities of SRF;

– Reference points of SRF;

– Information flows between SRF and other functions defined in DSN.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.2085	2016-06-13	13	11.1002/1000/12887

Keywords

Distributed service networking, DSN, functional architecture, service routing, service routing function, SRF.

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

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1 Scope

This Recommendation specifies service routing functions (SRF), which provide service registration, discovery, triggering and access mechanisms through distributed service networking (DSN), and the capabilities to improve service provision including load balance, charging agent, etc. Moreover, it describes the related reference points and possible protocols between functional entities in detail, and also defines detailed message flows of service routing.

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 Y.2080] Recommendation ITU-T Y.2080 (2012), *Functional architecture for distributed service networking*.

[ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 distributed service networking [b-ITU-T Y.2206]: An overlay network which provides distributed and manageable capabilities to support various multimedia services.

3.1.2 functional entity [b-ITU-T Y.2012]: An entity that comprises an indivisible set of specific functions. Functional entities are logical concepts, while groupings of functional entities are used to describe practical, physical implementations.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 service directory: An entity to accept the service registration requirement from an application server (AS) and supply the service/application list to the users.

3.2.2 service ID: A hash ID representing a certain service which will be registered in DSN.

3.2.3 service routing: A unified service supporting platforms built on DSN. It supplies the service registration, publication, discovery, triggering and access mechanisms, and enhanced capabilities to optimize the service provision.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AS Application Server

CDF Content Delivery Functions

CSAF Content Service Application Functions

DHT Distributed Hash Table

DSN Distributed Service Networking

EF End-user Functions

PaaS Platform as a Service

P2P Peer-to-Peer

RLF Resource Location Functions

SCF Service Control Functions

SD-FE Service Directory Functional Entity

SP Service Provider

SRF Service Routing Functions

SR-FE Service Routing Functional Entity

TOCF Traffic Optimization Control Functions

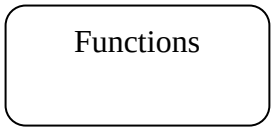
UE User Equipment

5 Conventions

The following conventions apply:

1) The meaning of functions is as follows:

Functions: In the context of DSN functional architecture, "functions" are defined as a functional group composed of functional entities. It is represented by the following symbol:



2) In this Recommendation:

DSN network means the network constructed based on DSN principles.

DSN service means the service supported by the DSN network.

DSN application server (AS) means the application server providing the DSN service.

DSN service provider (SP) means the service provider that makes use of the DSN network in order to provide services and applications to its users.

6 Requirements of service routing over DSN

DSN-based service routing provides service bootstrap, service registration, publication, discovery, triggering and access mechanism, and capabilities to optimize the service provision. It should support the following functional requirements:

1) From the aspect of a basic mechanism, service routing is required to support:

   a) Service bootstrap

      The DSN AS executes a bootstrap procedure before registering to DSN. The bootstrap enables service initialization, which selects and ensures the operation of the service. The AS can get the access information of DSN from the bootstrap.

   b) Service registration and publication

      The DSN AS registers in DSN and is published by DSN with a unified service ID.

   c) Service discovery

      The DSN service is discovered by its service ID.

   d) Service directory discovery

      Service directory is discovered by the DSN AS/end-user functions (EF).

   e) Service update

      The DSN service updates the service information registered in DSN.

   f) Service triggering and access

      The DSN service is triggered and accessed by the user through its service ID.

   g) Service deregistration

      The DSN AS deregisters and removes the service information in DSN.

2) From the aspect of the capability to improve service provision, service routing is recommended to support:

   a) Unified user authentication and authorization for DSN and service provider

   b) Load balance

      Based on the load balance of application servers, service routing can select the suitable AS for the users to access service.

      Service routing can select the AS in a suitable location to optimize the service provision when application servers are distributed in various places.

   c) Charging

      When a user accesses the service, DSN can act as the charging agent for the service providers.

7 Functional architecture of service routing

7.1 Functional architecture

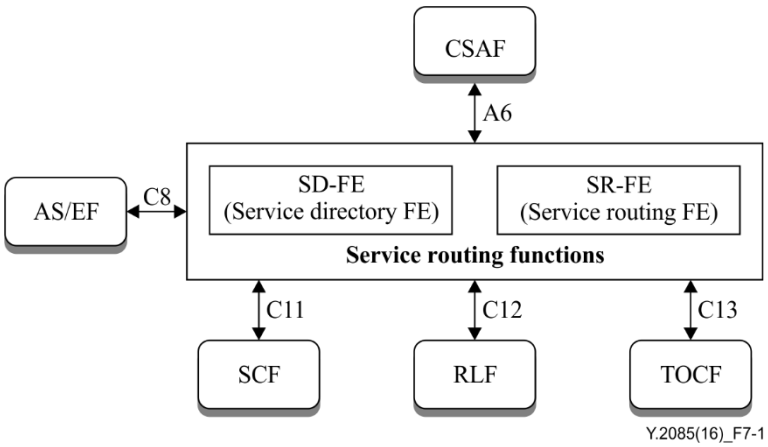


Figure 7-1 – SRF functional architecture

Figure 7-1 describes the service routing functions (SRF) functional architecture with functional entities and relevant reference points. This functional architecture includes:

– Service directory functional entity (SD-FE).

– Service routing functional entity (SR-FE).

7.1.1 Service directory functional entity

The SD-FE handles the following functions:

– The SD-FE supports the service registration from the SP. The SD-FE allocates service ID for the service and stores the detailed information of the registered service to the DSN through resource location functions (RLF).

– The SD-FE provides service access portal function to the user equipment (UE). When the UE queries a service, the SD-FE provides the service menu list to the UE. Once the UE chooses one service, the SD-FE sends the service ID to the UE.

7.1.2 Service routing functional entity

The SR-FE provides the service triggering and access mechanisms, and enhanced capabilities to optimize the service provision.

The SR-FE provides service information storage and management functions for the service. The service information contains the address, work load of application server, etc.

The SR-FE provides user authentication and authorization functions for the AS.

The SR-FE provides service triggering functions when the UE requests access from DSN. The SR-FE queries the service information through RLF by the service ID.

The SR-FE chooses the suitable AS according to load balance and geography factors.

The SR-FE provides confidential charging functions for the application providers.

7.2 Reference point and interface

7.2.1 Interface C8

The SR-FE interacts with the AS/EF via the reference point C8 to accept AS/EF connection requests, accept AS/EF service access requests and return the service access responses to the AS/EF.

The SD-FE interacts with the AS/EF via the reference point C8 to accept AS/EF service requests and return service responses to the AS/EF.

7.2.2 Interface C11

The SR-FE interacts with service control functions (SCF) via the reference point C11 to retrieve user profile and authentication information.

7.2.3 Interface C12

The SR-FE interacts with RLF via the reference point C12 to locate the responsible SR-FE based on a given service ID.

7.2.4 Interface C13

The SR-FE interacts with traffic optimization control functions (TOCF) via the reference point C13 to query network topology information for application server selection.

7.2.5 Interface A6

The SR-FE interacts with content service application functions (CSAF) via the reference point A6 to accept CSAF connection requests, accept CSAF service access requests and return the service access responses to the CASF.

The SD-FE interacts with the CSAF via the reference point A6 to accept CSAF service requests and return the service responses to the CSAF.

8 Basic information flows

8.1 Description

Service routing provides the mechanisms of service bootstrap, service registration, publication, discovery, triggering and access through DSN. Through the collaboration of DSN providers and the SPs, service routing can help to optimize the service provision by supplying the capabilities of service load balance, service management, etc. Service routing can also provide charging functions and other enhanced functions for the SPs under the participation of DSN.

In service routing, a user will discover and access the service by the service ID, and DSN will process charging and load balance based on the service ID.

The detailed information flows are described as follows.

8.2 Service bootstrap

The bootstrap flow is executed before the AS registers itself to the service routing network as a server, or executes before EF accesses a service through the service routing network.

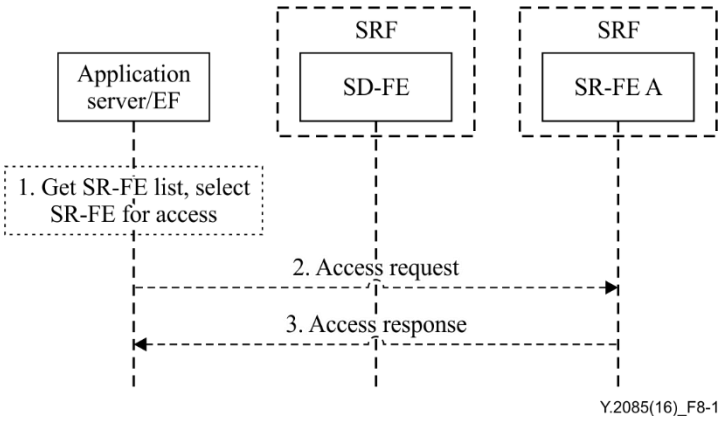


Figure 8-1 – Service bootstrap

1) Application server/EF gets an SR-FE list and selects one SR-FE for access.

2) Application server/EF sends a connect request to the selected SR-FE, and creates a connection successfully.

3) Application server/EF gets the access information from the SR-FE, such as local profile, remote profile server.

8.3 Service directory discovery

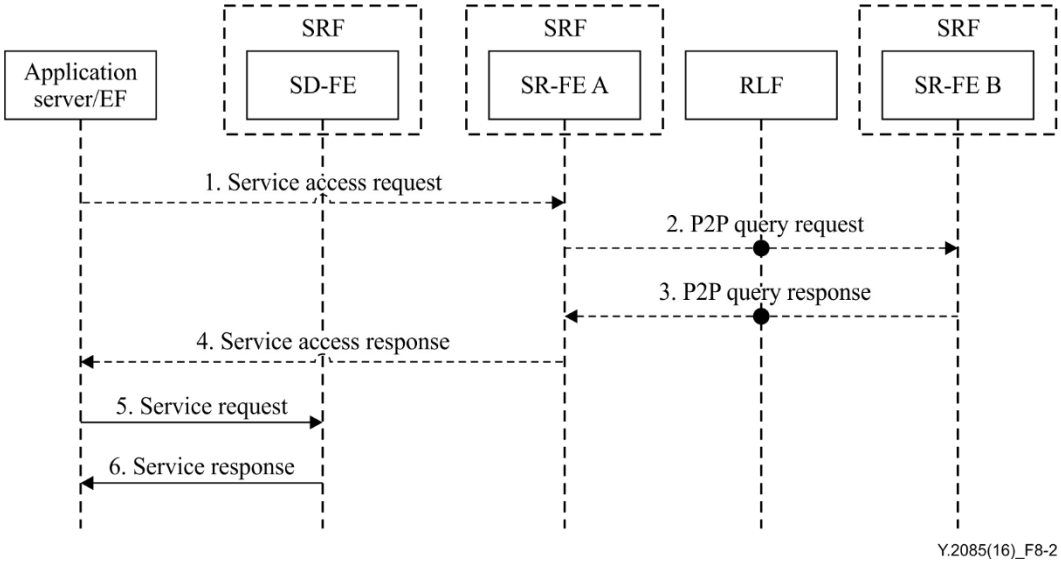


Figure 8-2 – Service directory discovery

1) While an application server/EF does not have the address of the SD-FE, the application server/EF first sends a service access request message to its associated SR-FE, e.g., SR-FE A, to find the SD-FE. The service access request message contains a service ID which is allocated for service directory.

NOTE – The ID for service can be pre-stored in the application server/EF.

2) SR-FE A sends a fetch request to the responsible SR-FE of the service information, i.e., SR-FE B, over peer-to-peer (P2P) overlay.

3) SR-FE B returns the P2P query response.

4) SR-FE A returns the service directory information to the application server/EF.

5) The application server/EF connects to the service directory, i.e., SD-FE, and sends a service request to retrieve the service list or lookup the service information.

6) SD-FE returns the service response to the application server/EF.

8.4 Service registration

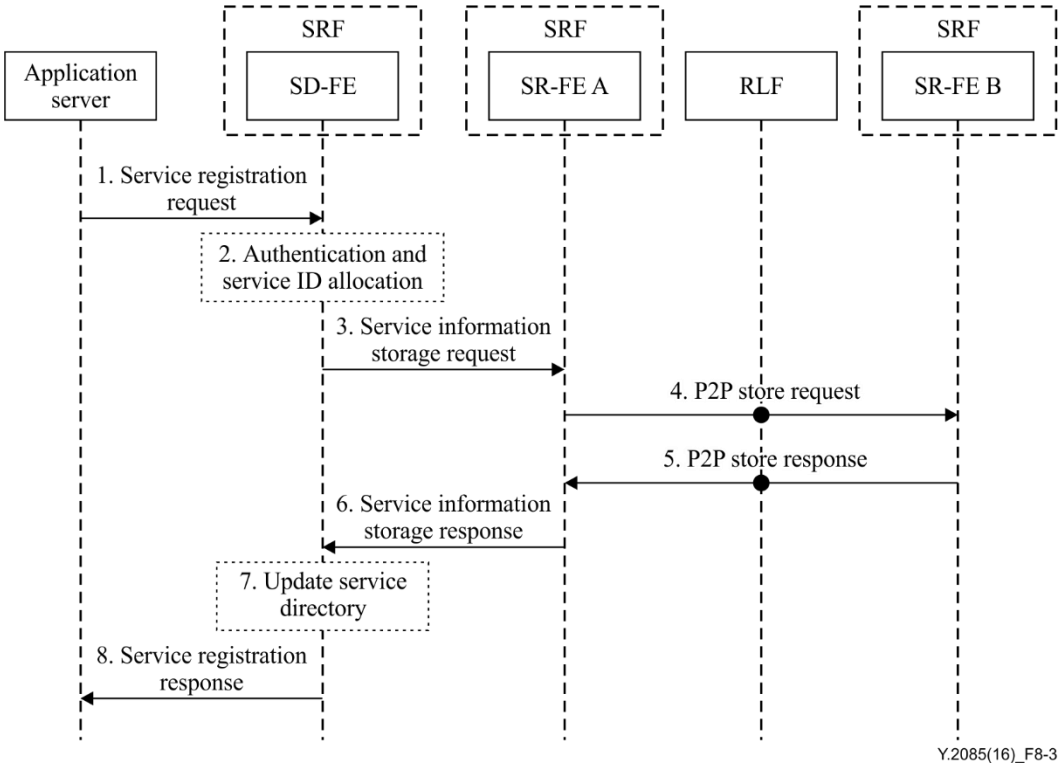


Figure 8-3 – Service registration

1) Application server sends the service registration request to the SD-FE to publish a specified service. The service information, including the application server address and service description, is contained in the message.

2) SD-FE authenticates the application server and allocates a service ID for the new service.

3) SD-FE sends a service information storage request to its associated SR-FE A. The service information, including service ID, application server address and service description, is contained in the message.

4) SR-FE A sends a store request to the responsible SR-FE of the service information, i.e., SR-FE B, over P2P overlay.

5) SR-FE B stores the information of the service and returns the P2P storage response.

6) SR-FE A returns the service information storage response.

7) SD-FE updates the service directory so that the new service is on the list.

8) SD-FE returns the service registration response to the application server to show that the registration is successful. The allocated service ID is included in the response.

8.5 Service update

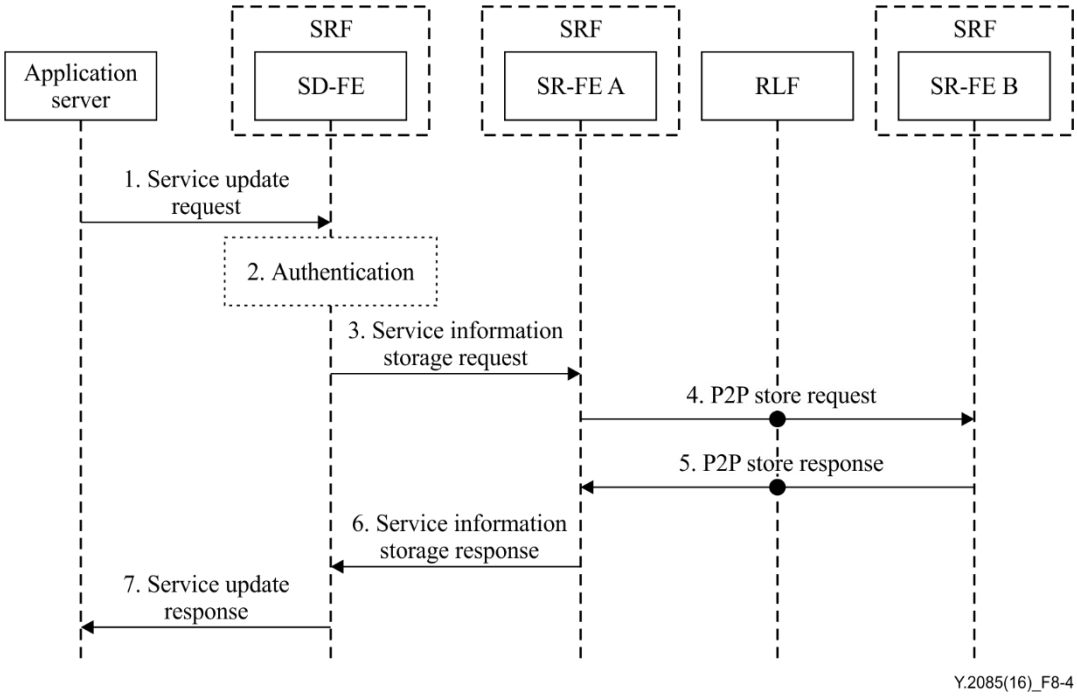


Figure 8-4 – Service update

1) Application server sends the service update request to the SD-FE to update the service information, e.g., add/delete application servers, change server load status. The service ID and updated service information are contained in the message.
2) SD-FE authenticates the application server.
3) SD-FE sends a service information storage request to its associated SR-FE A. The service ID and updated service information are contained in the message.
4) SR-FE A sends a store request to the responsible SR-FE of the service information over P2P overlay, i.e., SR-FE B.
5) SR-FE B stores the information of the service and returns the P2P storage response.
6) SR-FE A returns the service information storage response.
7) SD-FE returns the service update response to the application server to show that the update was successful.

8.6 Service deregistration

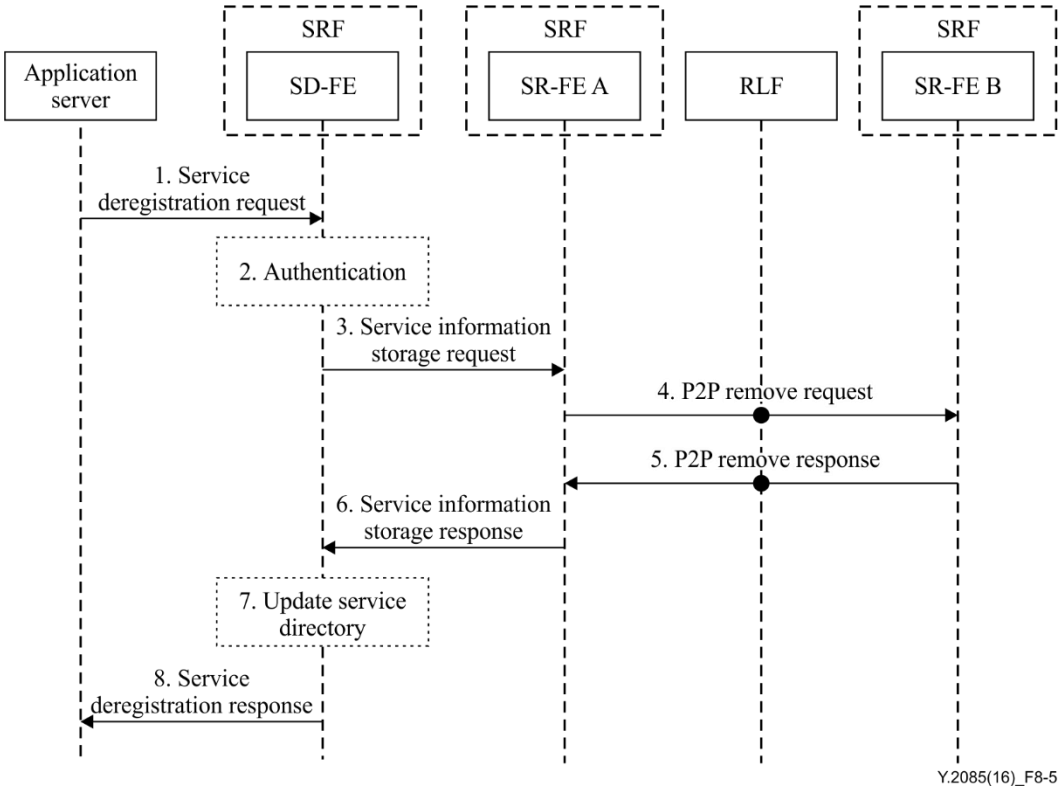


Figure 8-5 – Service deregistration

1) Application server sends the service deregistration request to the SD-FE to cancel the service from service routing network.
2) SD-FE authenticates the application server.
3) SD-FE sends a service information storage request to its associated SR-FE A to remove the service information.
4) SR-FE A sends a remove request to the responsible SR-FE of the service information, i.e., SR-FE B, over P2P overlay.
5) SR-FE B removes the information of the service and returns the P2P remove response.
6) SR-FE A returns the service information storage response.
7) SD-FE updates the service directory so that the service is removed from the list.
8) SD-FE returns the service deregistration response to the application server to show that deregistration was successful.

8.7 Service query

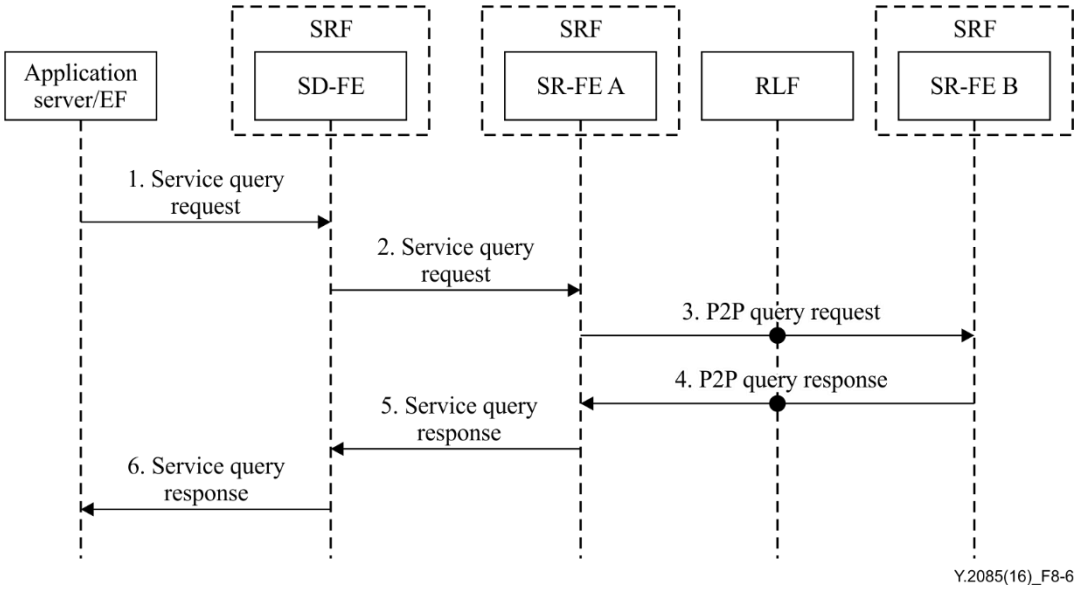


Figure 8-6 – Service query

1) Application server/EF queries information about a service. The application server/EF sends the service query request with the service ID to the SD-FE. The requested service information includes the service name, and/or application server list, etc.
2) SD-FE authenticates the application server/EF and sends the service query request to its associated SR-FE A.
3) SR-FE A sends a fetch request to the responsible SR-FE of the service information, i.e., SR-FE B, over P2P overlay.
4) SR-FE B returns the P2P query response.
5) SR-FE A returns the service query response.
6) SD-FE returns service query response to the application server or EF. The requested service information is included in the response.

8.8 Service access

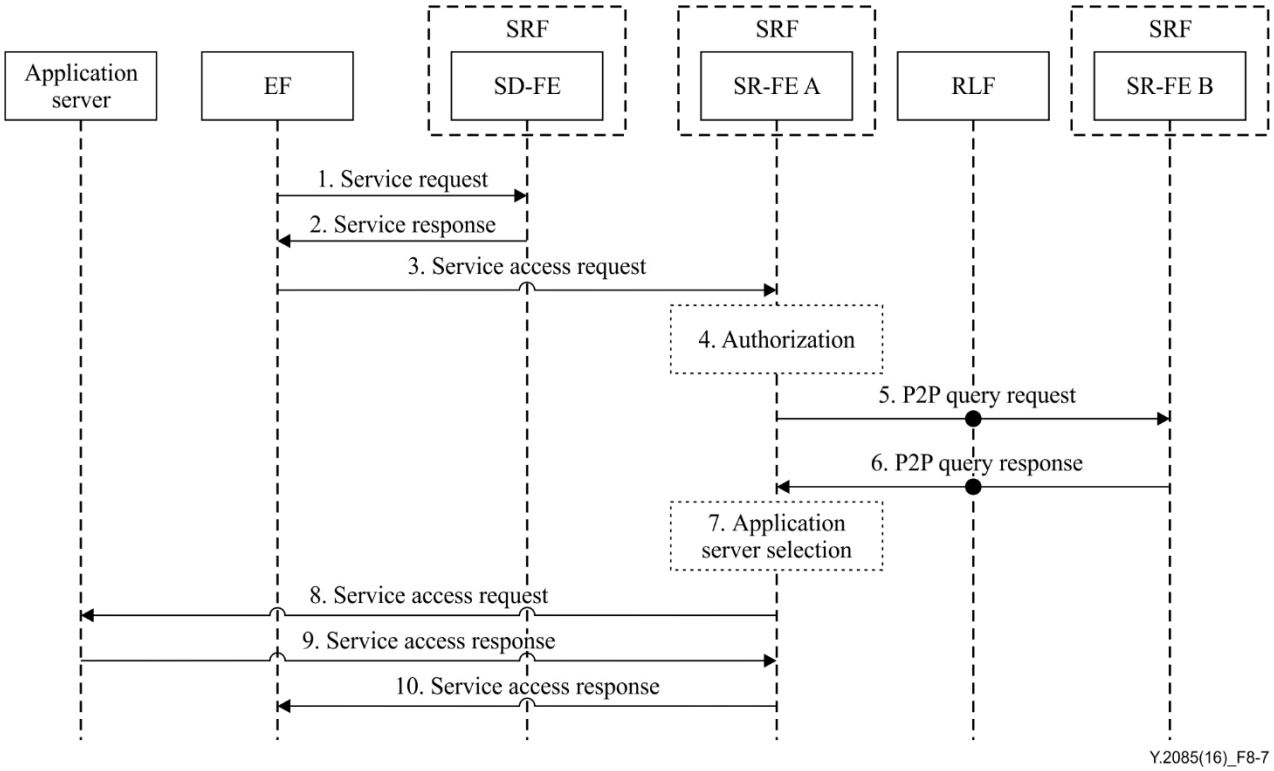


Figure 8-7 – Service access

1) When the EF wants to access service, it first sends service request to the SD-FE.
2) SD-FE sends a service response to the EF with basic service information including service ID.
3) EF sends a service access request to the SR-FE A with the service ID. The SR-FE A is the access SR-FE for the EF.
4) SR-FE A executes the authentication and authorization function and checks the user profile to determine if the EF has the right to access this service.
5) SR-FE A sends a fetch request to the responsible SR-FE B of the service information, i.e., SR-FE B, over P2P overlay.
6) SR-FE B sends the P2P query response to the SR-FE A. The response message includes detailed service information, e.g., the application servers' access address, load, and location.
7) SR-FE A selects an application server according to location, load balance, etc.
8) SR-FE A sends a service access request to the selected application server.
9) Application server sends the service access response to the SR-FE A.
10) SR-FE A forwards the service access response to the EF to start the service.

9 Security considerations

This Recommendation requires no specific considerations and aligns with the security requirements in [ITU-T Y.2701].

Appendix I

How DSN service routing contributes to the Internet service

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

DSN can provide P2P-based multimedia telephony service (MMTel) service control and support to streaming services. However, for Internet services, it is hard to have a network stratum to control the services, as NGN currently does. A new business model and a new ecosystem should consider how DSN could provide for Internet services in the future.

DSN service routing tries to solve this problem by presenting two mechanisms:

1) DSN service routing helps to publish the Internet service based on the carrier's subscribers. In this case, DSN service routing works as a service store for the Internet service.

2) DSN service routing opens some mature function components to the Internet service providers to facilitate Internet service development and provision. In this case, DSN service routing works as a platform as a service (PaaS) platform for the Internet service.

I.1 DSN service routing as a service store for Internet service

Telecommunication carriers have a large number of subscribers who could be the potential users of the Internet service.

DSN service routing provides a publication platform so that DSN subscribers can easily check out their favourite service and can easily access the service.

I.2 DSN service routing as PaaS platform for Internet service

Except for the core service logic implementation, most service providers are not rigorous in their accounting system, load balance, user management, and other such ancillary functions.

DSN service routing can provide many mature capability components for Internet service, including but not limited to:

1) Unified user account management

   DSN service routing can provide user authentication and authorization functions for the SP.

2) Charging proxy

   DSN service routing can provide a secure and confidential charging mechanism for the SP.

3) Work load information monitoring and load balance mechanisms

   Often there are many application servers necessary to provide a single service. DSN service routing can monitor the work load of the application servers and select the suitable servers. The geography factors can also be considered during the load balance procedure.

4) Service data storage

   DSN service routing can provide data storage capability to the SPs so that they do not need to build their own storage systems.

5) Network topology and the user location information

   DSN service routing can provide the user location service. DSN service routing can also provide traffic optimization based on the network topology information, perhaps with the help of DSN TOCF.

Based on the above mechanisms, DSN service routing can help Internet service providers focus on their core business development. It works in a different way to inter-operate with services as compared with NGN (while it is what the future Internet service environment needs).

Appendix II

DSN Service routing scenarios and benefits

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

II.1 Use cases related to service access

Figure II.1 shows UE access service through DSN service routing. In this clause, the DSN service routing use cases, during the service access procedure, are described.

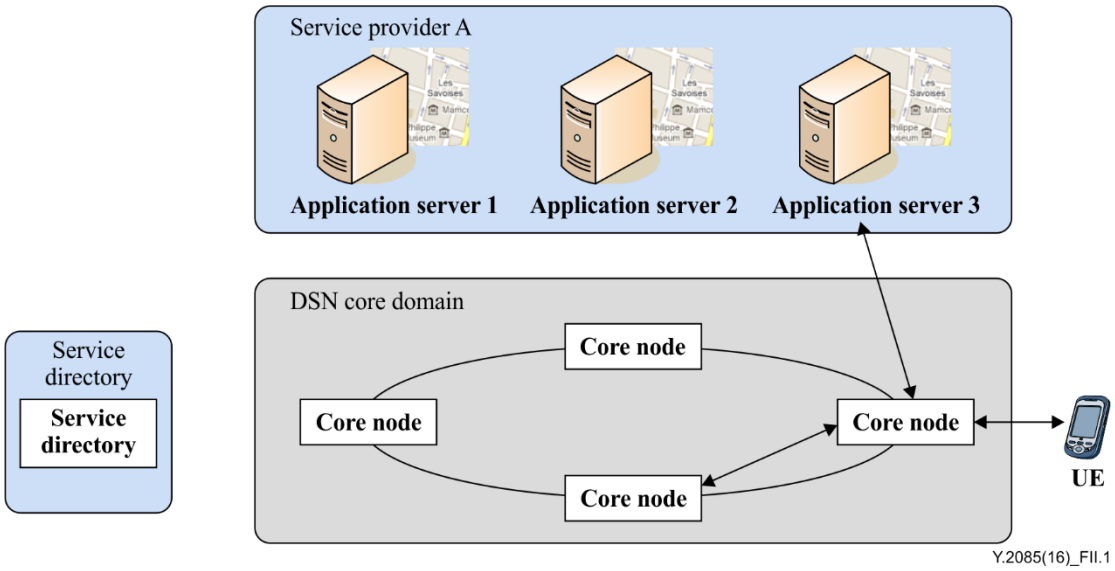


Figure II.1 – Service access

II.1.1 Unified user authentication and authorization

When the UE chooses a service from the service directory, the UE can connect to the DSN core node and request the service. Before the UE accesses the service, DSN will check if the UE can access this service for the SP. Only if the UE passes the DSN authentication and authorization, it can access the service.

As shown in Figure II.1, service provider A (hereafter, SP A) provides the map service. SP A signed a contract with the DSN provider, so SP A trusts in the subscribers of DSN. When the UE passes the DSN authentication and authorization, SP A will accept the UE's service request through DSN.

Compared with traditional service access, the UE should register with individual SPs and authenticate separately. In this case, it could improve the service access efficiency.

II.1.2 Charging

When the UE accesses a service for payment, the DSN core node can charge the user with his/her DSN account and then settle accounts with the SP later.

Petty account charging could be typical for this use case. Examples are given as follows:

1) The UE wants to download e-books from SP A and will be charged some money for every e-book downloaded. When the UE send a service request to SP A and confirms a download e-book, DSN will charge the UE to his DSN subscriber account and will settle accounts with SP A later. DSN can require commission charges from SP A.

2) SP B is an online game provider and also sells game currencies, time cards and virtual items. Players can pay through their DSN subscriber account when can access service through DSN.

3) SP C provides a map navigation service. When a user accesses this service through DSN service routing, they can choose to pay via their DSN account.

II.1.3 Load balance

A DSN node can keep alive with the application servers and update the work load information of the application server periodically. When DSN chooses the application server for the UE, the application server with the lower work load will be selected with a higher priority.

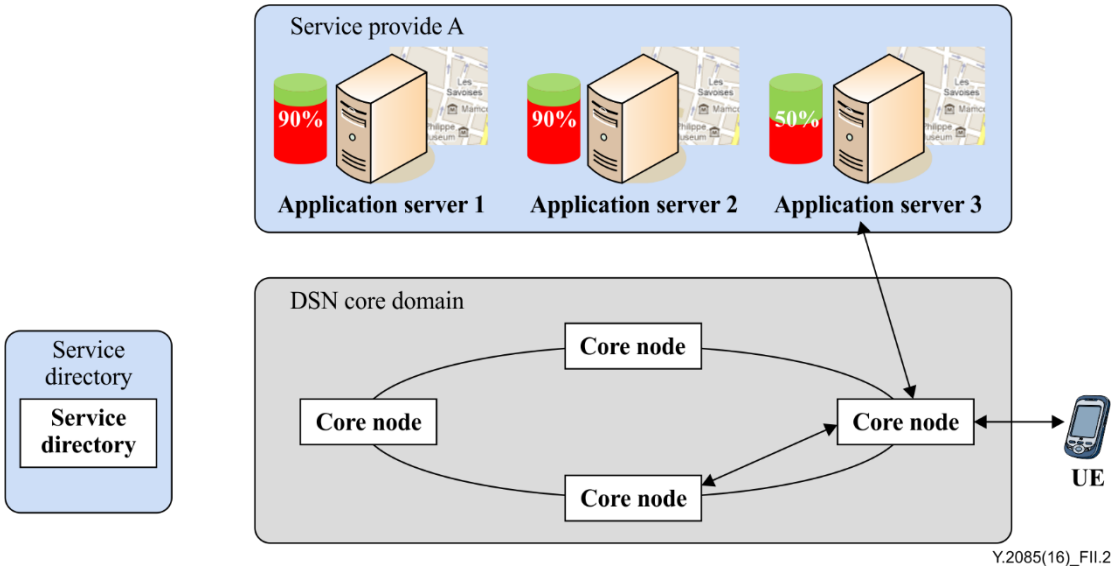


Figure II.2 – Load balance

As shown in the Figure II.2, SP A deployed three application servers to provide the map service. Each application service has a different workload. As shown, application server 1 and application server 2 have already been heavily burdened while application server 3 can still accept more service visits.

When the UE wants to access the service, DSN core node checks the current work status of the application servers and finds application server 3 has the lightest workload. Thus, application server 3 is selected as the service server for the UE. In the next step, the UE will receive service from application server 3.

II.1.4 Optimization based on location

When DSN chooses the application server for the UE, the location of the application servers and the UE will be considered. The application server geographically closest to the UE will be selected with a higher priority.

As shown in Figure II.3, SP A deploys three application servers to provide the map service. Application server 1~3 is located in Paris, Vancouver, and Beijing, respectively.

When a UE located in China requests the map service, DSN core node will select the application server 3 to provide the service.

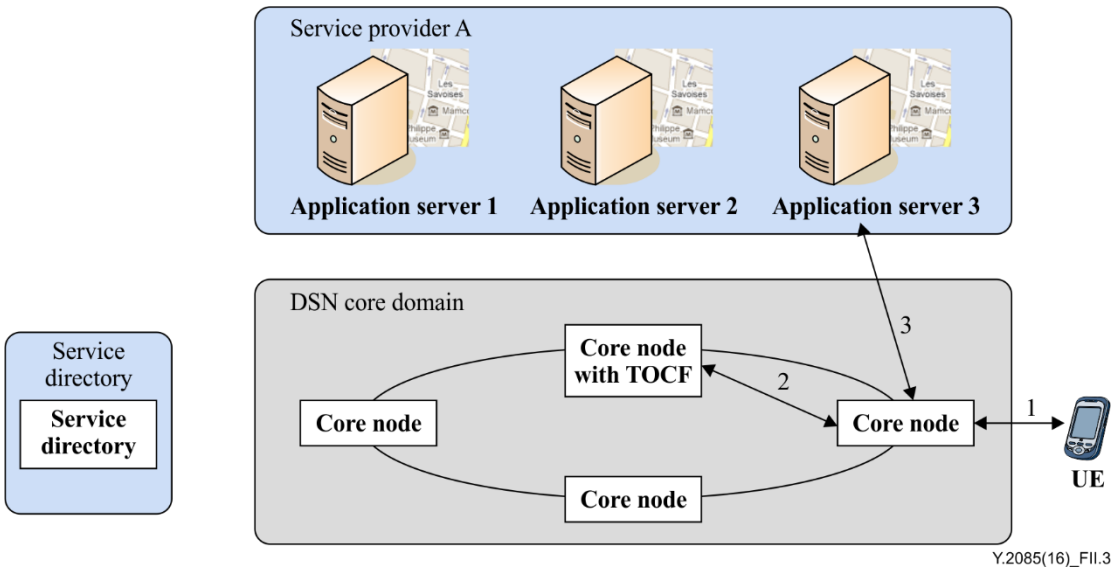


Figure II.3 – Location optimization by TOCF

In this use case, DSN service routing can cooperate with TOCF to find the geographically-closest application server.

For example, DSN core node sends the application server list to the TOCF. The TOCF will check and find application server 3 is closest to the UE, and then the TOCF will return the application server 3 as the best selection.

II.1.5 Service personalization

A DSN node can gather service usage information when a user accesses service through DSN. Using the per-user service usage information, e.g., service access frequency and service type, DSN service routing system can use data mining technology to derive the user preference. Therefore, DSN can provide more personalized services to its users. The user preference profile can be open to services managed by the DSN operator and third-party services. When user privacy is concerned, such information may only be used by trusted services managed by DSN operators.

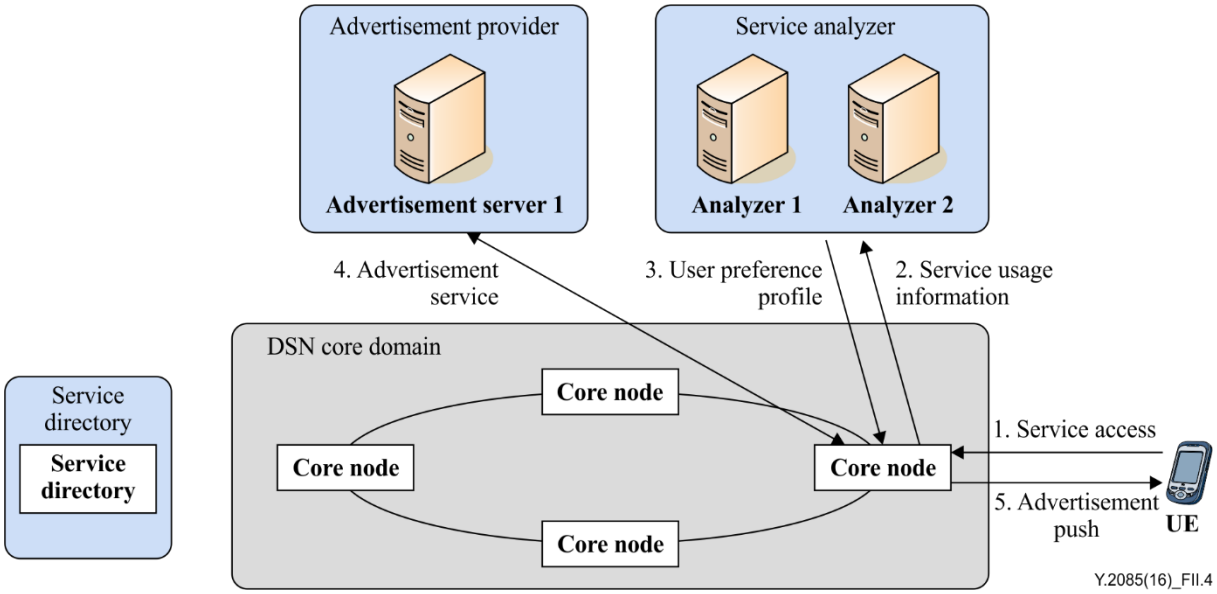


Figure II.4 – Personalized advertisement push

Figure II.4 shows an example of pushing a personalized advertisement to the UE. DSN service routing system gathers user service usage information when a user accesses services through DSN. The service usage information is sent to the service analyzer which uses data mining algorithms to derive a user preference profile. Based on the user preference, DSN can push the user-specific advertisements to the UE.

The advantage of personalized services is that DSN service routing provides an efficient way to gather service information and to apply user preferences to the service execution process. Compared to traditional service information gathering schemes, such as deep packet inspection (DPI), DSN provides a unified mechanism to identify services. Furthermore, DSN service routing can easily personalize the services by redirecting or adding parameters when routing the service requests.

II.1.6 Benefits

In these use cases, DSN service routing can provide the following benefits:

1) DSN can provide the SP with professional platform support such as authentication, authorization and accounting (AAA). The SP does not need to invest or can greatly reduce their investment to develop and maintain these functions by themselves, allowing that SP to focus on its key service development.

2) DSN can optimize service provision with the service-related information collected by DSN service routing system. For example, DSN can collect the user location and easily choose the best application server. Users can get better service quality of experience (QoE) so that it will greatly promote the competition capability of the SP.

3) For the newly started SPs, it is hard to provide complicated and sophisticated mechanisms for load balancing, optimization, etc. By the help of DSN service routing, a growing SP can easily fulfil these service optimization functions so as to focus on their key service development and release their service in the shortest time. This scenario is especially valuable for the SPs in their initial stage of development.

II.2 Service interconnection

SPs may need to connect to one another. Figure II.5 shows a use case where SPs connect to others SPs in order to provide more versatile service to their users.

In this case, SP A, alone, provides a travel map and tour guide service. To enhance their user experience, ticket booking and hotel booking services are also necessary; however, SP A cannot provide these services by itself. So SP A chooses to collaborate with SP B and SP C, which are ticket and hotel booking service providers.

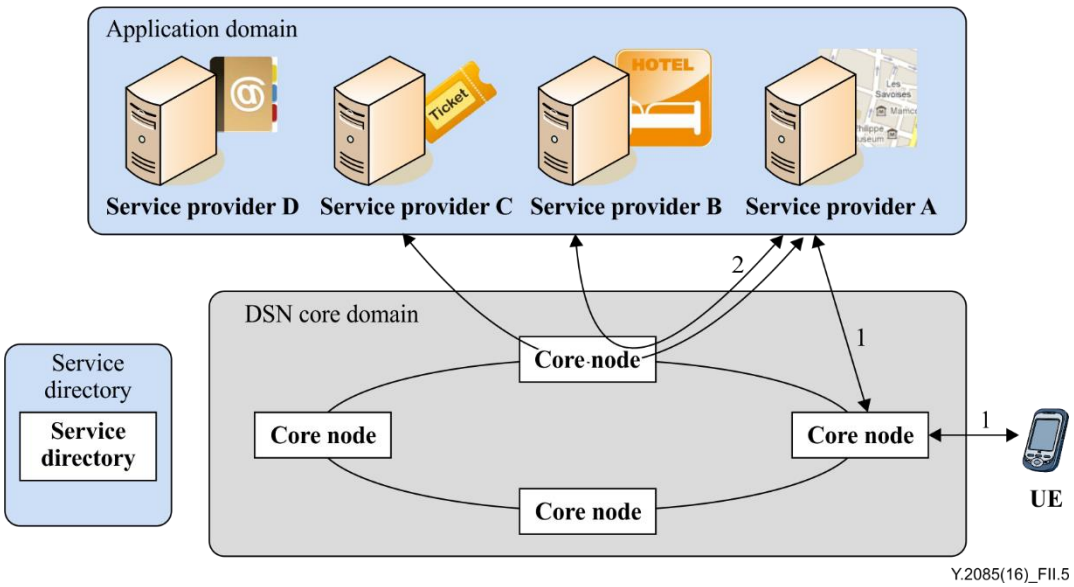


Figure II.5 – Service interconnection

As a precondition, SP A, SP B, and SP C sign separate contracts with DSN rather than contracting with one another. It could work in the following steps:

1) When the UE accesses SP A, the user wants to download a tour map and guide from SP A. In addition, the user also wants to book a hotel and a plane ticket through just one service access to save time and for convenience.

2) Through DSN service routing, SP A can access SP B and SP C and get the hotel and plane ticket booking services.

3) Finally, SP A provides these services to the UE.

Benefits

In this case, DSN service routing can simplify the business contract relationship between SPs and enhance the collaboration efficiency between SPs.

Especially for the newly started SP, it may need many partners to develop its service. Through DSN, it will be easier to achieve a wider partnership so as to quickly enhance a SP's service competition capability.

II.3 Service store use case

DSN service routing system works as the service publication platform for the SP. Services provided by different SPs can be registered and published through this platform. Since there are a large numbers of subscribers of the carrier, this will greatly increase the possibility that the services will be visited by more users. For the DSN subscribers, they can also more easily find and request their preferred services through this system.

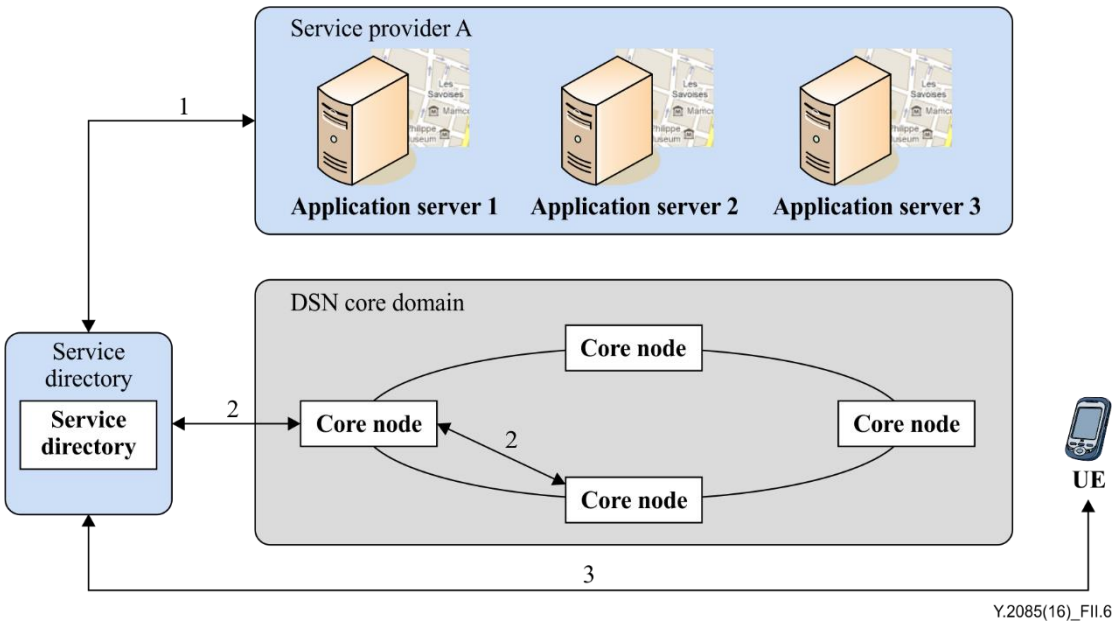


Figure II.6 – Service publication platform

In this case, SP A is a newly-founded map service provider. To let more users become acquainted with and access its service, SP A chooses to collaborate with a DSN provider to publish its service.

The following steps show how this works:

1) SP A connects with service directory and requests to store service related information into DSN. In order to guarantee the security of DSN, service directory works as an agent for the SP to avoid the SP directly accessing the distributed hash table (DHT) overlay. Service directory will allocate service ID for this service, which is a hash ID and uniquely refers to this service.

2) Service directory connects to the DSN core node. Based on the DHT algorithm, the service information data will be stored in the DSN responsible core node. This information can include e.g., service name, service ID, application server's location, workload, charging policy.

3) When the UE wants to use a map service, it connects to the service directory and checks the service in the map service category. The UE can easily find the map service provided by SP A. Once the UE selects the service, service directory will send the service ID to the UE. In this case, service directory works as the portal for the UE to query the service.

Benefits

By utilizing the subscriber resource of the carrier, the service would be discovered and accepted by many more users. Excessive advertisement expenditures bring challenges to the SPs, and this will significantly lower the advertising cost for the SP, especially for those growing SPs. Furthermore, it also helps users and third-party mashup service providers to find services. To the DSN operator, they will glean more dividends as more services are published in the platform.

Appendix III

An illustration of service profile's structure

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

The service profile is the data structure that presents the service related information. An example is shown below:

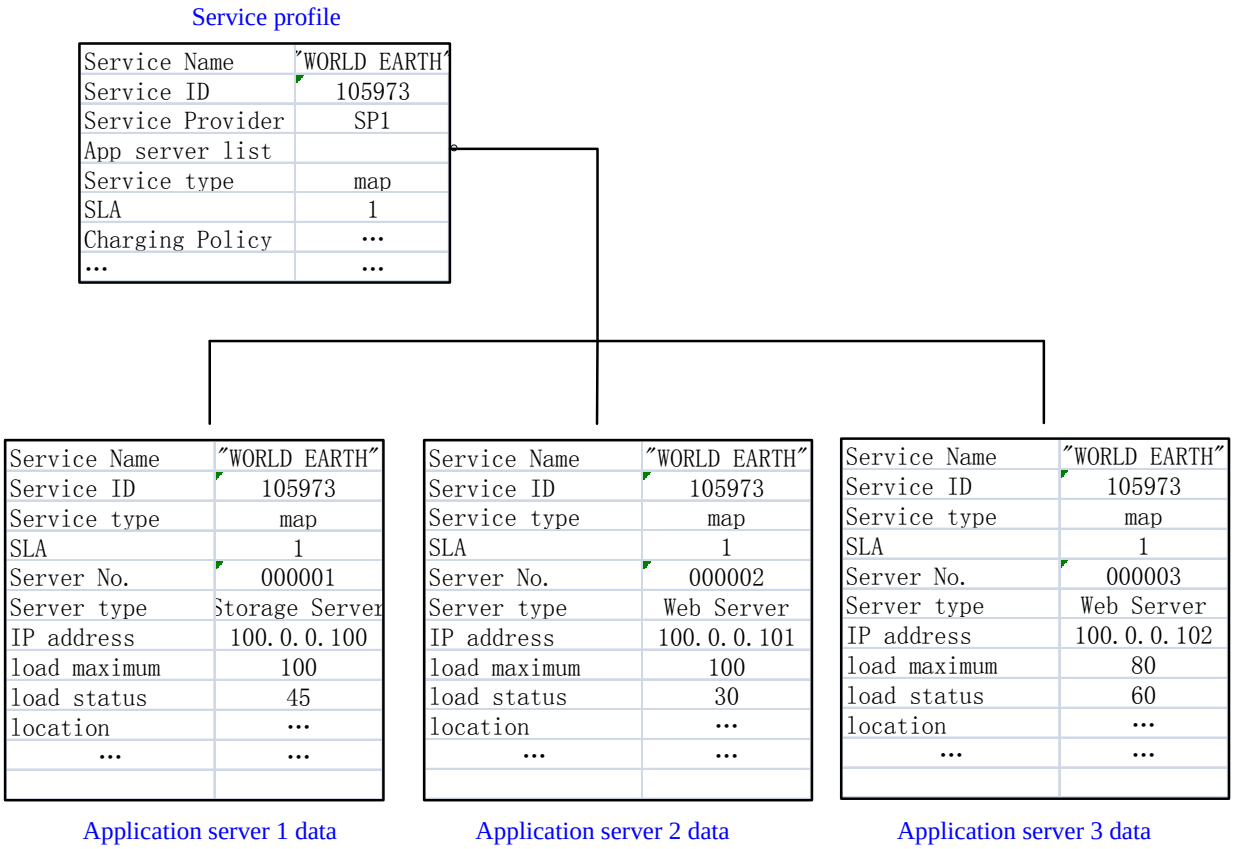


Figure III.1 – Example of service profile

As shown in Figure III.1, the service profile is comprised of many attributes, e.g., service name, service ID, service provider, application server list, service type, service level agreement (SLA), charging policy. The service profile is generated while the AS initiates the registration procedures to the SRF. The SRF assigns a service ID to the service using DHT algorithms, and configures the attributes of the service profile. Then the profile will be forwarded to the control node that is responsible to keep it according to DHT.

An operating service is supported by many different kinds of application servers, there is an attribute 'App servers list' in the service profile to demonstrate the application servers of the service. The application server data shows the attributes of the application servers, e.g., service name, service ID, service type, SLA, server no., server type, control node, IP address, load capability, load status, location.

The service profile is the management information of the services in DSN. It is used in the flows of service subscription, service access and the service related scenarios. It can also used to select the optimal server to serve the users by determining the location and load of the available application servers.

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