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SERIES Q: SWITCHING AND SIGNALLING

Signalling requirements and protocols for the NGN – network signalling and control functional architecture

Signalling architecture for the control plane of distributed service networking

Recommendation ITU-T Q.3051

International Telecommunication Union

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Recommendation ITU-T Q.3051

Signalling architecture for the control plane of distributed service networking

Summary

Recommendation ITU-T Q.3051 describes the overall signalling architecture for the control plane of distributed service networking. It identifies the functions, physical entities (PEs), interfaces and protocols that will model the control plane for distributed service networking (DSN).

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.3051	2015-06-13	11	11.1002/1000/12491

Keywords

Control plane, DSN, signalling architecture.

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* 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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Recommendation ITU-T Q.3051

Signalling architecture for the control plane of distributed service networking

1 Scope

This Recommendation provides signalling architecture for control plane of distributed service networking (DSN). Based on the functional architecture and the service provisioning in DSN, it specifies the mapping of functions into PEs and the mapping of reference points to interfaces in DSN architecture when deploying content service and multimedia telephony (MMTel) service over DSN. It also describes the protocols used for interfaces and security considerations, etc.

2 References

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

[ITU-T Q.1741.6] Recommendation ITU-T Q.1741.6 (2009), *IMT-2000 references to Release 8 of GSM- evolved UMTS core network.*

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2010), *Functional requirements and architecture of next generation networks*.

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

[ITU-T Y.2206] Recommendation ITU-T Y.2206 (2010), *Requirements for distributed service networking capabilities*.

[IETF RFC 768] IETF RFC 768 (1980), *User Datagram Protocol*.

[IETF RFC 2326] IETF RFC 2326 (1998), *Real Time Streaming Protocol (RTSP)*.

[IETF RFC 2616] IETF RFC 2616 (1999), *Hypertext Transfer Protocol – HTTP/1.1*.

[IETF RFC 3550] IETF RFC 3550 (2003), *RTP: A Transport Protocol for Real-Time Applications*.

[IETF RFC 4825] IETF RFC 4825 (2007), *The Extensible Markup Language (XML) Configuration Access Protocol (XCAP)*.

[IETF RFC 6940] IETF RFC 6940 (2014), *REsource LOcation And Discovery (RELOAD) Base Protocol*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

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

3.1.2 functional entity [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

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AF Application Function

CDF Content Delivery Function

CSAF Content Service Application Function

DHT Distributed Hash Table

DSN Distributed Service Networking

EF End-user Function

HTTP Hypertext Transfer Protocol

ID Identification

MMTel Multimedia Telephony

NEF Node Enrolment Function

PE Physical Entity

RELOAD Resource Location And Discovery

RF Relay Function

RLF Resource Location Function

RTP Real-time Transport Protocol

RTSP Real Time Streaming Protocol

SCF Service Control Function

SIP Session Initiation Protocol

TOCF Traffic Optimization Control Function

UDP User Datagram Protocol

UE User Equipment

5 Conventions

None.

6 Control architecture and functions

This clause summarizes the DSN functional architecture as described in [ITU-T Y.2080], see Figure 6-1.

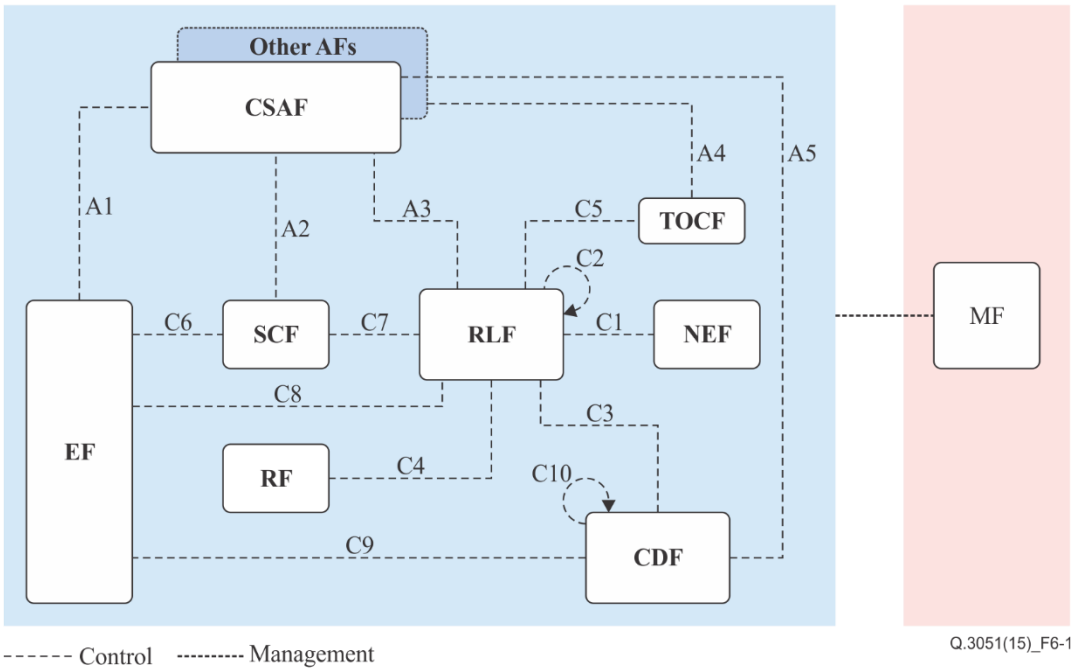

Figure 6-1 – DSN functional architecture

6.1 Functions

6.1.1 Node enrolment functions (NEFs)

The NEF allocates a globally unique node identification (ID) to each enrolling DSN node, provides bootstrap information for a DSN node to join to the distributed hash table (DHT)-based DSN network, and maintains the node profile.

6.1.2 Resource location functions (RLFs)

The RLF maintains resource-related information and finds the required resources when inquired.

6.1.3 Relay functions (RFs)

The RF relays particular application traffic for DSN nodes to achieve NAT/firewall traversal and QoS improvement.

6.1.4 Content delivery functions (CDFs)

The CDF stores, processes and delivers content to DSN nodes or user equipment (UE).

6.1.5 Traffic optimization control functions (TOCFs)

The TOCF monitors and analyses network information, and provides guidance to DSN nodes in order to make the delivery and distribution of application traffic in the DSN network more efficient and cost-effective.

6.1.6 Management functions (MFs)

The MFs inherit the MF functions defined in [ITU-T Y.2012], which include fault management, configuration management, accounting management, performance management, security management functions, etc.

6.1.7 Service control functions (SCFs)

In DSN, the SCF defined in the NGN architecture [ITU-T Y.2012] is reused for service control.

6.1.8 End-user functions (EFs)

The EF is a function of DSN UE, which supports access to a DSN network and services.

6.1.9 Content service application functions (CSAFs)

The CSAF is an application function (AF) responsible in the DSN functional architecture for the provision of content-related services to the EF.

The functions are described in detail in [ITU-T Y.2080].

6.2 Reference points

6.2.1 Reference point C1

The C1 reference point is between NEF and RLF.

C1 is used by RLF to request the enrolment of a DSN node in which the RLF resides in the DHT-based DSN network.

C1 is used by NEF to provide configuration and bootstrap information to the RLF regarding a DSN node that newly joins the DHT based overlay in DSN network.

6.2.2 Reference point C2

The C2 reference point is between RLFs.

C2 is used to exchange the information that constructs and maintains the DHT based overlay in a DSN network.

C2 is also used to forward resource location requests or resource location update requests to RLFs.

6.2.3 Reference point C3

The C3 reference point is between RLF and CDF.

C3 is used by CDF:

- to register content to RLFs;
- to request RLF for content location information;
- to report to RLF the status of a node in which the CDF resides. The status information includes: CPU usage, memory usage, disk usage, network interface usage, etc.;
- to report event related information to RLF, for instance, the event may be that the load of the node in which CDF resides reached threshold;
- to report content related information to RLF, for instance, the content availability or content popularity, etc.

6.2.4 Reference point C4

The C4 reference point is between RF and RLF.

C4 is used by RF to register the relay node in which it resides to RLF.

C4 is used by RF to report the status of the node in which it resides to RLF, the status information includes: CPU usage, memory usage, disk usage, network interface usage, etc.

C4 is used by RF to report event related information to RLF, for instance, the event may be that the load of the node in which RF resides reached threshold.

C4 is used by RF to report the QoS measurement message to RLF.

C4 is used by RLF to reserve resources on RF.

6.2.5 Reference point C5

The C5 reference point is between TOCF and RLF.

C5 is used by RLF to enquire TOCF about network information and to request traffic optimization results from TOCF.

6.2.6 Reference point C6

The C6 reference point is between EF and SCF.

C6 is used to exchange service control related information between EF and SCF. For instance, registration information or service request information.

6.2.7 Reference point C7

The C7 reference point is between RLF and SCF.

C7 is used by SCF to request resource location from RLFs.

6.2.8 Reference point C8

The C8 reference point is between RLF and EF.

C8 is used by EF to request resource location from RLF.

6.2.9 Reference point C9

The C9 reference point is between EF and CDF.

C9 is used by EF to query a buffer map and request content from CDF.

6.2.10 Reference point C10

The C10 reference point is between CDFs.

C10 is used by CDF to query a buffer map and request content from another CDF.

6.2.11 Reference point A1

The A1 reference point is between EF and CSAF.

A1 is used by EF for accessing content services and requesting content location.

6.2.12 Reference point A2

The A2 reference point is between SCF and CSAF.

A2 is used for user authentication and authorization.

6.2.13 Reference point A3

The A3 reference point is between CSAF and RLF.

A3 is used by CSAF to request RLF for the available content node.

6.2.14 Reference point A4

The A4 reference point is between AF and TOCF.

A4 is used by AF to query and subscribe the specific traffic related information.

6.2.15 Reference point A5

The A5 reference point is between CDF and CSAF.

A5 is used by CSAF to control CDF to process (e.g., transcoding, encryption) content.

The reference points are described in detail in [ITU-T Y.2080].

7 Physical entities and interfaces in DSN architecture

When implementing a DSN architecture, some of the functions identified in [ITU-T Y.2080] may be grouped and implemented in a number of PEs. The PEs and protocols used on the interfaces may be different when deploying different application services over DSN. For example, the PEs and protocols used for content services may be different than those used for MMTel services. In this Recommendation, the physical architectures are described based on service categories deployed over DSN.

When a PE includes several functions defined in [ITU-T Y.2080], some of the reference points between functions may be implemented as internal interfaces.

7.1 PEs and interfaces for content services over DSN

Figure 7-1 illustrates an example of grouping functions when deploying content services over DSN.

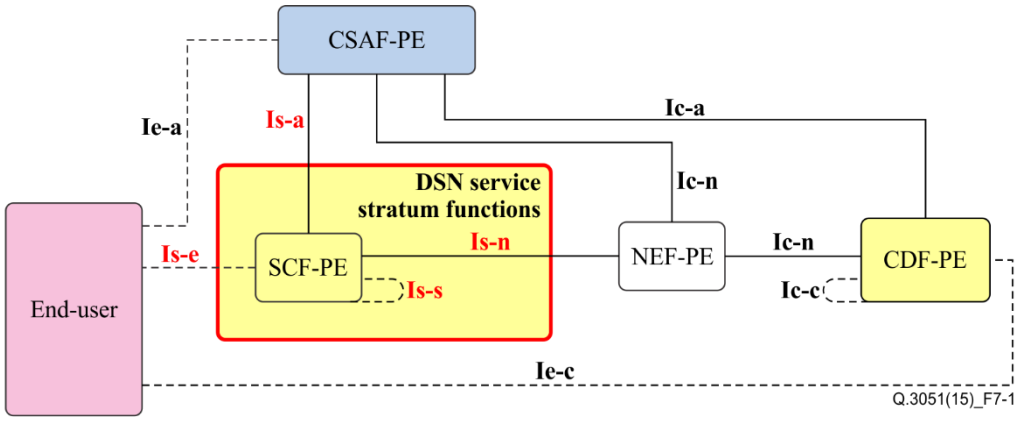

Figure 7-1 – PEs and interfaces of DSN architecture for content services

7.1.1 Mapping functions into PEs

The mapping of functions into PEs is shown in Table 7-1.

One PE may implement several ITU-T Y.2080 functions, and some reference points between functions may be converted to internal interfaces.

Table 7-1 – Mapping functions into PEs

Physical Entity	Description	Functions included
CSAF-PE	Physical entity for the content service application function	Content service application function, Resource location functions, traffic optimization control functions, management functions, etc.
SCF-PE	Physical entity for the service control function	Service control functions, resource location functions
CDF-PE	Physical entity for the content delivery function	Content distribution and location control functions, content delivery and storage functions
NEF-PE	Physical entity for node enrolment functions	NEFs, including authentication and authorization to a new enrolling DSN node, etc.

Table 7-1 – Mapping functions into PEs

Physical Entity	Description	Functions included
End user	Physical entity for the end-user function	End-user functions

7.1.2 Mapping reference points to interfaces

The mapping of reference points to interfaces is shown in Table 7-2.

Table 7-2 – Mapping reference points to interfaces

DSN architecture for content services		Interface description
Interfaces	Mapping reference points	
Is-a	A2	Interface between SCF-PE and CSAF-PE
Is-e	C6, C8	Interface between SCF-PE and end user
Is-n	C1	Interface between SCF-PE and NEF-PE
Is-s	C2	Interface between SCF-PE and SCF-PE
Ic-c	C10	Interface between CDF-PE and CDF-PE
Ie-a	A1	Interface between CSAF-PE and end user
Ie-c	C9	Interface between CDF-PE and end user

7.2 PEs and interfaces when deploying MMTel service over DSN

Figure 7-2 illustrates an example of grouping functions when deploying MMTel service over DSN.

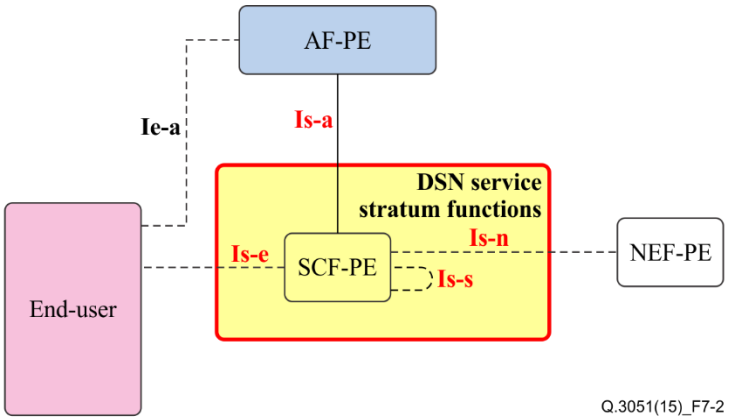

Figure 7-2 – PEs and interfaces of DSN architecture for MMTel service

7.2.1 Mapping functions into PEs

The mapping of functions into PEs is shown in Table 7-3.

Table 7-3 – Mapping functions into PEs

PE	Description	Functions included
AF-PE	Physical entity for the application function	Application support functions and service support functions for MMTel service
SCF-PE	Physical entity for the service control function	Service control functions, resource location functions, etc.
NEF-PE	Physical entity for node enrolment functions	NEFs, including authentication and authorization to a new enrolling DSN node, etc.
End user	Physical entity for the end-user function	End-user functions

7.2.2 Mapping reference points to interfaces

The mapping of reference points to interfaces is shown in Table 7-4.

Table 7-4 – Mapping reference points to interfaces

DSN architecture for content services		Interface description
Interfaces	Mapping reference points	
Is-a	A2	Interface between SCF-PE and AF-PE
Is-e	C6, C8	Interface between SCF-PE and end user
Is-n	C1	Interface between SCF-PE and NEF-PE
Is-s	C2	Interface between SCF-PE and SCF-PE
Ie-a	A1	Interface between AF-PE and end user

8 Protocols used for interfaces

8.1 Protocols used for interfaces when deploying content services over DSN

Interfaces which are included in Figure 7-1 of DSN architecture for content services are listed in Table 8-1.

Table 8-1 – Protocols used for interfaces in DSN architecture when deploying content services

Interfaces	Interface description	Protocols	Relevant specifications
Is-a	Interface between SCF-PE and CSAF-PE	Hypertext Transfer Protocol (HTTP)	[IETF RFC 2616]
Is-e	Interface between SCF-PE and end user	Real time streaming protocol (RTSP)	[IETF RFC 2326]
Is-n	Interface between SCF-PE and NEF-PE	REsource LOcation And Discovery (RELOAD)	[IETF RFC 6940]

Table 8-1 – Protocols used for interfaces in DSN architecture when deploying content services

Interfaces	Interface description	Protocols	Relevant specifications
Is-s	Interface between SCF-PE and SCF-PE for resource location	RELOAD	[IETF RFC 6940]
Ic-c	Interface between CDF-PE and CDF-PE	RELOAD	[IETF RFC 6940]
Ie-a	Interface between CSAF-PE and end user	HTTP	[IETF RFC 2616]
Ie-c	Interface between CDF-PE and end user	Real-time Transport Protocol (RTP) over user datagram protocol (UDP)	[IETF RFC 3550] and [IETF RFC 768]

8.2 Protocols used for interfaces when deploying MMTel service over DSN

Interfaces which are included in Figure 7-2 of DSN architecture for MMTel service are listed in Table 8-2.

Table 8-2 – Protocols used for interfaces in DSN architecture when deploying MMTel service

Interfaces	Interface description	Protocols	Relevant specifications
Is-a	Interface between SCF-PE and AF-PE	Session Initiation Protocol (SIP)	[ITU-T Q.1741.6] (Note)
Is-e	Interface between SCF-PE and end user for resource location	RELOAD	[IETF RFC 6940]
	Interface between SCF-PE and end user for session control	SIP	[ITU-T Q.1741.6] (Note)
Is-n	Interface between SCF-PE and NEF-PE	RELOAD	[IETF RFC 6940]
Is-s	Interface between SCF-PE and SCF-PE for resource location	RELOAD	[IETF RFC 6940]
	Interface between SCF-PE and SCF-PE for session control	SIP	[ITU-T Q.1741.6] (Note)
Ie-a	Interface between AF-PE and end user	XCAP	[IETF RFC 4825]
NOTE – [ITU-T Q.1741.6] endorsed the 3GPP specifications that specify the SIP protocol used in this interface.			

9 Security considerations

The signalling architecture for DSN is required to support security mechanisms of session control as supported by the protocols identified in clause 8. Other service specific security requirements are out of scope of this Recommendation.

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