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

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

Signalling requirements for service function discovery

Recommendation ITU-T Q.3059

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Recommendation ITU-T Q.3059

Signalling requirements for service function discovery

Summary

Recommendation ITU-T Q.3059 specifies the signalling requirements for service function discovery based on its functional architecture. The signalling is for the service function path controller to discover and select the service function.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q.3059	2020-09-29	11	11.1002/1000/14412

Keywords

Service function, service function discovery, signalling requirements.

* 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.3059

Signalling requirements for service function discovery

1 Scope

This Recommendation covers:

– Overview of service function discovery (SFD);

– Functional architecture of SFD;

– Information flow of SFD;

– Signalling requirements of SFDi (SFD interface);

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.

[IETF RFC 7665] IETF RFC 7665 (2015), *Service function chaining (SFC) architecture*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 service function chain (SFC) [b-ITU-T Y-Sup.41]: A chain that defines an ordered set of abstract service functions and ordering constraints that must be applied to packets and/or frames and/or flows selected as a result of classification and/or policy.

3.1.2 service function forwarder (SFF) [IETF RFC 7665]: A service function forwarder is responsible for forwarding traffic to one or more connected service functions according to information carried in the service function chain (SFC) encapsulation, as well as handling traffic coming back from the service function (SF). Additionally, an SFF is responsible for delivering traffic to a classifier when needed and supported, transporting traffic to another SFF (in the same or different type of overlay), and terminating the service function path (SFP).

3.1.3 service function path (SFP) [IETF RFC 7665]: A constrained specification of where packets assigned to a certain service function path must go. While it may be so constrained as to identify the exact locations, it can also be less specific. The SFP provides a level of indirection between the fully abstract notion of service chain as a sequence of abstract service functions to be delivered, and the fully specified notion of exactly which service function forwarder (SFF)/service functions (SFs) the packet will visit when it actually traverses the network. By allowing the control components to specify this level of indirection, the operator may control the degree of SFF/SF selection authority that is delegated to the network.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 network service header (NSH): A type of encapsulation for service function controllers that is designed to encapsulate an original packet or frame and, in turn, be encapsulated by an outer transport encapsulation (which is used to deliver the NSH to NSH-aware network elements).

NOTE – Definition based on [b-IETF RFC 8300].

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CGN Carrier-Grade NAT

DPI Deep Packet Inspection

NAT Network Address Translation

NSH Network Service Header

RSP Rendered Service Path

SF Service Function

SFC Service Function Chain

SFD Service Function Discovery

SFF Service Function Forwarder

SFP Service Function Path

5 Conventions

In the body of this Recommendation, the words shall, shall not, should and may sometimes appear, in which case they are to be interpreted, respectively as, is required to, is prohibited from, is recommended and can optionally. The appearance of such phrases or keywords in an appendix or in material explicitly marked as informative are to be interpreted as having no normative intent.

{A}: indicates that the parameter A is mandatory.

6 Overview

Service function chain (SFC) enables the creation of composite services that consist of an ordered set of service functions. The main activities of SFC are the collection and management of network resources over geographically distributed networks.

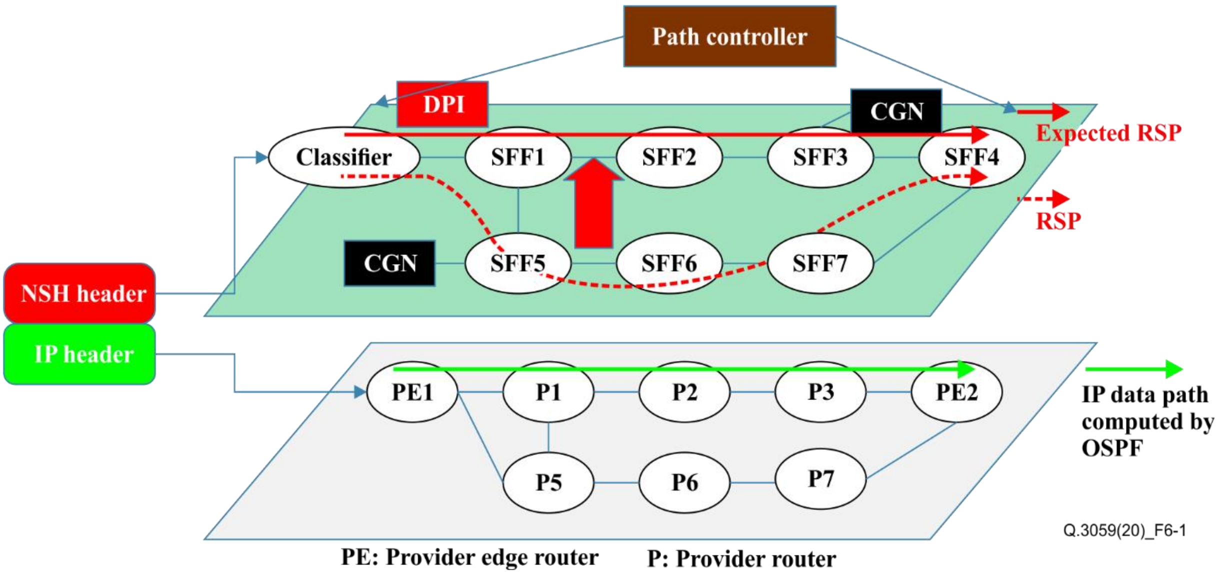

Figure 6-1 – The SFC path calculation problem

The discovery of service functions is a primary step for implementing SFC. The service function path (SFP) used in a real network (also called rendered service path (RSP)) is computed by SFFs or a path controller by choosing the closest service function instances. However, the path calculated in this way may introduce unnecessary latency to the packet transmission, as shown in Figure 6-1:

(1) The original IP data path calculated by IP route protocol is PE1-P1-P2-P3-PE2;

(2) Assume that there are two service functions which the packets should be passed through. One is deep packet inspection (DPI) residing on SFF1, the others are carrier-grade NATs (CGNs) residing on the SFF3 and SFF5. After DPI processes the packets, the SFF1 needs to find the next SFF to forward the packet. Since the SFF5 is much closer to SFF1 than SFF3, SFF1 chooses SFF5 to forward the packet. So, the final RSP is classifer-SFF1-SFF5-SFF6-SFF7-SFF4 whose corresponding IP data path is PE1-P1-P5-P6-P7-PE2.

(3) The RSP calculated in this way is much longer than the original IP data path and introduces extra latency. If SFF1 chooses SFF3 as the CGN forwarder, the RSP is classifer-SFF1-SFF2-SFF3-SFF4 and it is the same as the original IP data path.

Since the NSH layer is separated from the IP layer, the SFF cannot choose service function instances closest to the original IP data path and generates extra latency. Therefore, it is crucial for the SFP controller to discover service function instances and calculate the SFP based on the IP data path information.

7 Functional architecture of the service function discovery

[b-ITU-T Y.Suppl.41] provides the control plane and data plane of SFC which are shown in Figure 7-1.

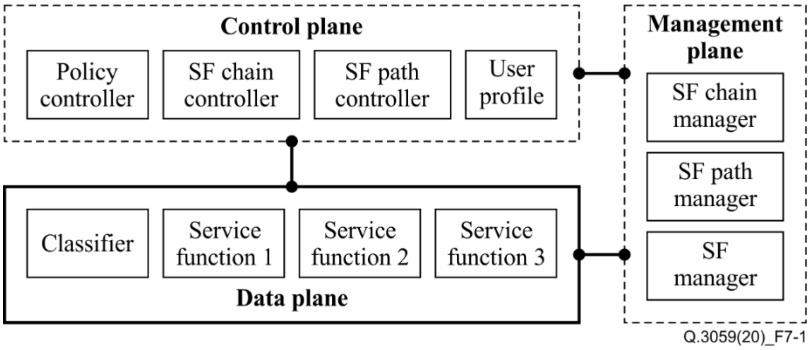

Figure 7-1 – Control plane and data plane of service function chaining

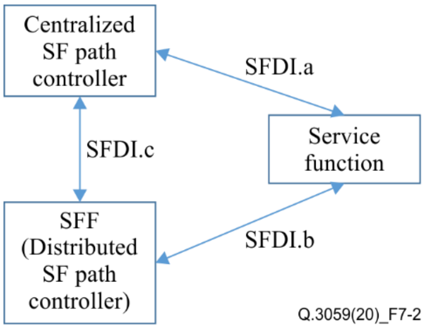

Figure 7-2 – Functional architecture of service function discovery

Figure 7-2 presents the functional architecture of service function discovery. The centralized service function (SF) path controller functional component is responsible for service function path calculation. According to the problem stated in clause 6, to calculate the shortest SFP, the centralized SF path controller needs to collect the information of all the service function instances and SFFs' locations.

SFF (also known as distributed SF path controller) functional component is responsible for finding out the distance between the service function instances and itself, and figuring out the service function forwarding table based on the distance information.

The interface SFDi is responsible for service function discovery and is among three entities as shown in Figure 7-2.

(1) The SFDi.a is responsible for individual service function instance registration. This interface is between the centralized SF path controller functional component and the service function functional component.

(2) The SFDi.b is responsible for distance information collection. This interface is between the distributed SF path controller functional component and the service function functional component.

(3) The SFDi.c is responsible for transmitting the service function instance information between the centralized SF path controller functional component and SFF. The service function information includes:

a) IP addresses and ports of service function instance;

b) Distance between the specific SFF and the specific service function instance.

8 The information flow of SFD

Figure 8-1 presents the information flow of the service function discovery through interface SFDi.

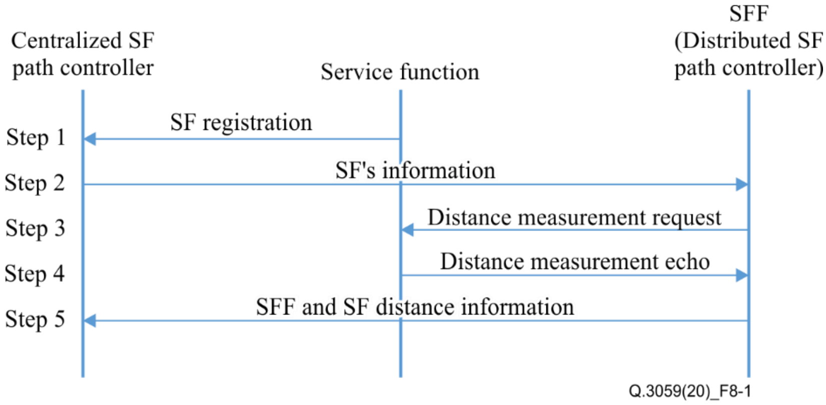

Figure 8-1 – The service function discovery procedure through interface SFDi

Step 1: The service function instance uses SFDi.a to register itself to the centralized SF path controller.

Step 2: The centralized SF path controller uses SFDi.c to send the IP information of the collected service function instance to all the SFFs.

Step 3: SFFs use SFDi.b to send request message to the service function instance to measure the distance between them.

Step 4: The service function instance replies to the SFF's request through SFDi.b. When SFF receives the echo message, it calculates the distance between them, including the number of IP hops and latency.

Step 5: The SFF sends the service function instance's distance information to the centralized SF path controller through SFDi.c.

NOTE – How the centralized SF path controller collects the SFF information is out of the scope of this Recommendation.

9 Signalling requirements of the SFDi

9.1 Signalling requirements of SFDi.a

The SF registration request message is defined as SF-REG-RQ message.

The SF-REG-RQ message, indicated by the message type in the message header field, is sent by the service function instance to the centralized SF path controller in order to register itself.

Message format:

```
<SF-REG-RQ-Message> ::= < Message Header >
                         {SF-IP-Address-Port}
                         {SF-Type}
```

Meanings and explanations:

The detailed SF information indicates, but not limited to:

1.`SF-IP-Address-Port` uniquely specifies the IP address and port information of the service function instance.

2.`SF-Type` uniquely specifies the type for service function instance, for example DPI.

The SF registration response message is defined as SF-REG-RP message.

The SF-REG-RP message, indicated by the message type in the message header field, is sent by the centralized SF path controller to the service function instance in order to respond its request.

Message format:

```
<SF-REG-RP-Message> ::= < Message Header >
                 {SF-Instance-ID}
```

Meanings and explanations:

The detailed SF information indicates but not limited to:

1. `SF-Instance-ID` uniquely specifies the global service function instance ID.

9.2 Signalling requirements of SFDi.b

The service function instance distance information request message is defined as SFDIS-REG-RQ message.

(1) The SFDIS-REG-RQ message, indicated by the message type in the message header field, it is sent from the SFF to the service function instance to calculate the distance between SFF and service function instance.

Message format:

```
<SFDIS-RES-RQ-Message> ::= < Message Header >
                 {SF-IP-Address-Port}
                        {SF-Instance-ID}
                        {SFF-ID}
```

Meanings and explanations:

The detailed information indicates, but not limited to:

1. `SF-IP-Address-Port` uniquely specifies the IP address and port of service function instance.

2. `SF-Instance-ID` uniquely specifies the service function instance ID.

3. `SFF-ID` uniquely specifies the SFF ID.

The SF distance information response message is defined as SFDIS-REG-RP message.

The SFDIS-REG-RP message, indicated by the message type in the message header field, is sent by the service function instance to SFF to respond to its request.

Message format:

```
<SFDIS-REG-RP-Message> ::= < Message Header >
                  {SF-Instance-ID}
                  {SF-IP-Address-Port}
                  {Latency}
                  {IP-Hops}
                  {SFF-ID}
```

Meanings and explanations:

SF distance information, the detailed information indicates but not limited to:

1. `SF-Instance-ID` uniquely specifies the service function instance ID.

2. `SF-IP-Address-Port` uniquely specifies the service function instance's IP address and port.

3. `Latency` uniquely specifies the latency between the specific SFF and the specific service function instance.

4. `IP-Hops` uniquely specifies the IP hops between the specific SFF and the specific service function instance.

5. `SFF-ID` uniquely specifies the SFF ID.

9.3 Signalling requirements of SFDi.c

The distance information request message is defined as DIS-REG-RQ message.

The DIS-REG-RQ message, indicated by the message type in the message header field, is sent by the centralized SF path controller to all the SFFs to request the distance information between the specific service function instance and each SFF, respectively.

NOTE – The information carried in this message is as same as the SFDIS-REG-RQ message.

Message format:

```
<DIS-RES-RQ-Message> ::= < Message Header >
                         {SF-IP-Address-Port}
                         {SF-Instance-ID}
```

Meanings and explanations:

The detailed information indicates but not limited to:

1. `SF-IP-Address-Port` uniquely specifies the IP address and port information of service function instance.

2. `SF-Instance-ID` uniquely specifies the service function instance ID.

The service function instance's distance information response message is defined as DIS-REG-RP message.

The DIS-REG-RP message, indicated by the message type in the message header field, is sent by the SFF to the centralized SF path controller.

Message format:

```
<DIS-REG-RP-Message>::= < Message Header >

                 {SF-Instance-ID}
                 {SF-IP-Address-Port}
                 {Latency}
                 {IP-Hops}
                 {SFF-ID}
```

Meanings and explanations:

SF distance information, the detailed information indicates, but not limited to:

1. `SF-Instance-ID` uniquely specifies the service function instance ID.

2. `SF-IP-Address-port` uniquely specifies the service function instance's IP address and port.

3. `Latency` uniquely specifies the latency between the specific SFF and the specific service function instance.

4.`IP-Hops` uniquely specifies the number of IP hops between the specific SFF and the specific service function instance.

5. `SFF-ID` uniquely specifies the SFF ID.

Bibliography

[b-ITU-T Y-Sup.41] Supplement 41 to ITU-T Y-series Recommendations (2016), *Deployment models of service function chaining*.

[b-IETF RFC 8300] IETF RFC 8300 (2018), *Network service header (NSH)*.

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