Network Working Group
INTERNET-DRAFT
Intended Status: Informational
Expires: March 08,2023
J. Dai
X. Wang
J. Gao
Fiberhome/CICT
September 08,2022

Architecture and application scenario for fused service function chain

draft-dai-sfc-fused-architecture-and-scenario-03

Abstract

This document discusses the architecture and application scenarios of fused service function chain. Fused service function chain means that two or more service function chains are fused to become a single service function chain from the view of data plane, control plane and management plane.
Fused service function chain is an expansion for general service function chain.Anyhow, some mechanism or methods need to be used when two or more service function chains are fused to be a single service function chain based on architecture described in this memo.

Table of Contents

1. Introduction

The delivery of end-to-end services often requires various service functions. These include traditional network service functions such as firewalls and traditional IP Network Address Translators (NATs), as well as application-specific functions. The definition and instantiation of an ordered set of service functions and subsequent "steering" of traffic through them is termed Service Function Chaining (SFC).[RFC7665]. [RFC7498] describes the motive for service function chain.

```
    o . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
      .  +--------------+                  +-------------------~~~
      .  |   Service    |       SFC        |  Service  +---+   +---+
      .  |Classification|  Encapsulation   | Function  |sf1|...|sfn|
   +---->|   Function   |+---------------->|   Path    +---+   +---+
      .  +--------------+                  +-------------------~~~
      . SFC-enabled Domain
    o . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

Figure 1: Architecture of service function chain

RFC 7665 has also described a high-level logical architecture of an SFC-enabled domain that can be seen in figure 1 (see also figure 2 of RFC 7665).

```
                        +------------+
                        |Subdomain#1 |
                        |  in DC1    |
                        +----+-------+
                             |
                     .---- SFF1 ------.   +----+
           +----+   /     /  |         \--|CF#4|
       --->|CF#1|--/---->'   |          \ +----+
           +----+ /  SC#1    |           \
                  |          |            |
                  |          V    .------>|--->
                  |         /    /        |
                   \        |   /        /
            +----+  \       |  /        /  +----+
            |CF#2|---\      | /        /---|CF#3|
            +----+    '---- SFF2 ------'    +----+
                             |
                        +----+-------+
                        |Subdomain#2 |
                        |   in DC2   |
                        +------------+
           Legend:
             SC#1: Service Chain 1
               DC: Data Center
```

Figure 2: Architecture for hierarchical service function chain

There are many application scenarios that can use technologies or methods related to service function chain. However, some application scenarios have not yet been covered by RFC 7665.

RFC 8459 has illustrated the difficult problem of implementing SFC across a large, geographically dispersed network, potentially comprised of millions of hosts and thousands of network-forwarding elements and which may involve multiple operational teams (with varying functional responsibilities). The adaptive layout for such circumstance is given in figure 2 (see also figure 1 of RFC 8459).

Hierarchical service function chain described in RFC 8459 is only one of the application scenarios that have not been covered by RFC 7665. Many other application scenarios that can be enhanced by service function chain can't yet be covered by RFC 8459. Then new architecture and requirements are needed.

About some other application scenarios, there is also a need to fuse two or more independent service function chains to Form a single service function chain from the view of data plane, control plane and management plane.

For example, when an enterprise network includes two or more physically separated sub-networks, it is possible to deploy two correlated service function chains in the two or more independent sub-networks respectively. However, logically and functionally, the two or more correlated service function chains should be thought as an identical service function chain.

1.1 Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

2. Architecture of Fused Service Function Chain

2.1. General Architecture for Fused Service Functional Chain

As is described in clause 1, there is a need to fuse two or more service fucntion chains to form a single service chain when service function chain is applied in some application scenarios. the afore-mentioned single service function chain is called fused service function chain (F-SFC).

At first, a F-SFC is composed of two or more service function chains that are logically independent each other and possibly seperate physically.

Secondly, a F-SFC can be thought as a single service function chain from the view of data plane,control plane and management plane. That is to say, data packet can be steered through all selected SFs within the

F-SFC according to preset configuration. moreover, a F-SFC can be managed by a management entity and the management entity can think the F-SFC as an ordinary service function chain.

Thirdly, all service function chains within a F-SFC can still work as an independent service function chain. In other words, if a F-SFC consists of SFC A, SFC B and SFC C, SFCs with the F-SFC such as SFC A can also be used as an independent if it is needed.

```
   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
   . +--------------+             +---------------------~~~
   . |   Service    |    SFC      |  Service   +----+    +----+
   . |Classification| Encapsulation| Function  |sf11|...|sf1n|
+--->|   Function   |+------------>|   Path     +----+    +----+
   . +--------------+             +---------------------~~~
   .
   .

   . +--------------+               +---------------------~~~
   . |   Service    |    SFC         |  Service  +----+   +----+
   . |Classification| Encapsulation| Function  |sf21|...|sf2m|
+--->|   Function   |+-----^------>|   Path    +----+   +----+
  |. +--------------+      |         +---------------------~~~
  |      Bypass            |
  +-----------------------+
+--->......
   . +--------------+               +---------------------~~~
   . |   Service    |    SFC         |  Service   +----+   +----+
   . |Classification| Encapsulation| Function  |sfk1|...|sfkl|
+--->|   Function   |+-----^------>|   Path      +----+   +----+
  |. +--------------+      |         +---------------------~~~
  |      Bypass            |
  +-----------------------+
   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

Figure 3: General architecture for fused service function chain

Figure 3 describes a general architecture of F-SFC. From the figure, it can be learned that the F-SFC is composed of SFC1, SFC2 ... and SFCj. SFC1 consists SF11, SF12 ... and SF1n. SFC2 consists SF21, SF22 ... and SF2m. ... SFCk consists SFk1, SFk2 ... and SFkl.

All SFs within SFC1, SFC2 ... and SFCj can be used by F-SFC. On the one hand, SFs within SFC(i+1) should be used after SFs within SFC(i) in order to keep the logical order of SFCs. On the other hand, SFs within the same SFC should take action based on logical order of the SFC.

It is noted that all CFs (Classification Function) in SFC2 ... SFCk can be configurated to work in By-pass mode in order that SFC2 ... SFCk can action based on the result of the CF in SFC1. It is sure all CFs can also work in normal mode.

2.2. Interface in the Fused Service Function Chain

It can also be learned from figure 3 that some interfaces are needed to compose a F-SFC.

At first, a kind of interface between SFC(i) and SFC(i+1) need to be deployed in order to connect SFC(i) and SFC(i+1) seamlessly.

Secondly, some interfaces within SFC(i) are also necessary to implement the F-SFC. For example, when CF in SFC(i) is by-passed, an interface should be used to connect the ingress end of the CF and the egress end of the CF.

Thirdly, there are some interfaces to be designed to connect F-SFC and outside of the F-SFC.

2.3. OAM Architecture for Fused Service Function Chain

2.3.1. Additional OAM Components

RFC 8924 describes the OAM framework for service function chain. CF component, SF component and SFC component are three main components related to SFC OAM.

F-SFC is substantially different from ordinary SFC, so the components related to OAM within F-SFC are also differnet from that within an ordinary SFC.

All the afore-mentioned CF component, SF component and SFC component are still effective in F-SFC. And there are three additional components to be taken into account:

- F-SFC components.

- Interface components.

- SFF components.

2.3.2. Additional OAM Functions

RFC 8924 also describes some OAM functions as follows:

- Connectivity functions.

- Continuity functions.

- Trace functions.

- Performance measurement functions.

There are some other OAM functions that are necessary to F-SFC such as some functions described as follows.

- Discovery function.

- Service awareness function.

3 Application Scenarios of Fused Service Function Chain

3.1. F-SFC for Wide-area Enterprise Network

```
                           Service Function Chain  A
                       +---+      +---+      +---+
                       |SF1|      |SF2|  ... |SFm|
        +------+       +---+      +---+      +---+
        |      |         |          |          |
        |Classi|       +-----+    +-----+    +-----+
    --->|fier  |--->   | SFF1|----| SFF2|----| SFFn|
        |      |       +-----+    +-----+    +-----+
        +------+
                          (~~~~~~~~~~)
                         (   Other    )
                 -------->  (              )-------->
                         (  network   )
                          (          )
                           ~~~~~~~~~~
                        Service Function Chain  B
                       +---+      +---+       +---+
                       |SF1|      |SF2|   ... |SFl|
        +------+       +---+      +---+       +---+
        |      |         |          |           |
        |Classi|       +-----+    +-----+    +-----+
    --->|fier  |--->   | SFF1|----| SFF2|----| SFFk|
        |      |       +-----+    +-----+    +-----+
        +------+
```

Figure 4: Logical structure for F-SFC in enterprise network

The first typical application scenario of F-SFC is wide-area enterface network. A large-scale enterprise often has two or more parts seperated each other physically. Then, there are also two or more physically seperated sub-networks that are owned by the same enterprise and corresponding to those seperated parts of the enterprise.

For example, if an enterprise has part A located in city A and part B located in city B, there is a sub-network A deployed in part A meanwhile there is also a sub-network B deployed in part B.

It is possible that a SFC A is designed in sub-network A and a SFC B is designed in sub-network B. However, some functions can be implemented by co-operation of SFC A and SFC B. Coordination between SFC A and SFC B can be realized by co-operation of management entities for sub-network A and sub-network B. Nevertheless, it is a better solution to use F-SFC.

Figure 4 describes the logical structure for F-SFC in wide-area enterprise network.

3.2. F-SFC in Cross-domain Scenario

```
   +--------------------------------------------------+
   |  Domain A       Service Function Chain  A        |
   |                 +---+      +---+      +---+      |
   |                 |SF1|      |SF2|  ... |SFm|      |
   |     +------+    +---+      +---+      +---+      |
   |     |      |      |          |          |        |
   |     |Classi|    +-----+    +-----+    +-----+    |
   | --->|fier  |--->| SFF1|----| SFF2|----| SFFn|    |--->
   |     |      |    +-----+    +-----+    +-----+    |
   |     +------+                                     |
   +--------------------------------------------------+

       +--------------------------------------------------+
       |    Domain B     Service Function Chain  A        |
       |                 +---+      +---+      +---+      |
       |                 |SF1|      |SF2|  ... |SFm|      |
       |     +------+    +---+      +---+      +---+      |
       |     |      |      |          |          |        |
       |     |Classi|    +-----+    +-----+    +-----+    |
   --->| --->|fier  |--->| SFF1|----| SFF2|----| SFFn|    |
       |     |      |    +-----+    +-----+    +-----+    |
       |     +------+                                     |
       +--------------------------------------------------+
```

Figure 5: Logical structure for F-SFC in cross-domained SFC

Figure 5 describes another application scenario in which the two SFCs to be fused belong to two different network domains. Although the two SFCs are in different network domains, they can be deployed in the same physical location.

For example, if SFC A is deployed in a ipv4 network domain, meanwhile SFC B is in a Srv6 network domain. SFC A and SFC B can be thought to be in different network domain.

It is also possible for SFC A in network domain A and SFC B in network domain B to be fused to a more powerful F-SFC.

3.3. SFC as a Service in Cloud

```
                          (~~~~~~~~~~~~~~~~~~~~~~~~~~)
                         (   +---+                    )
                        (    |SFi|     +---+           )
                       (     +---+     |SFj|            )
                      (                +---+             )
         +------+    (                                    )
         |Classi|   (                CLOUD                 )
                     (       +---+                        )
         |fier  |-->  (      |SFk|            +----+     )
         +------+      (     +---+            |... |    )
                        (            +----+   +----+   )
                         (           |SFFl|           )
                          (          +----+          )
                           (                        )
                            ~~~~~~~~~~~~~~~~~~~~~~~~
```

Figure 6: Logical structure for F-SFC in SFCaaS

With the development of the network function virtualization and cloud computing, it will be a gerenal mode to realize some network functions based on cloud.

On the other hand, some network functions should also be deployed in SFC mode when the network functions are implemented by a series of functional entities in order.

In addition, it is a proper solution to implement some network functions based on cloud mode and SFC mode. For example, realization of big data pre-processing function needs more network resources and would better be designed according to distributing mode. Many functional entities in the network cloud can be used to finish part or big data pre-processing function. However, those function entities need to be organized as a SFC under some circumstances.

SFC in cloud is called SFCaaS (SFC as a Service) in this document. Figure 6 depicts the logical structure for SFCaaS. About SFCaaS, the SFC components except CFs come from the cloud.

SFCaaS relies on SFs and SFFs in the cloud, so it is not easy to organize a SFC. Then, a network funciton will possibly be realized by cooperation of a group of SFCs. Thus, F-SFC is a candidate solution for this application scenario.

3.4. F-SFC in Mobile Edge Computing

At present, mobile edge computing (MEC) has become a hot research point. Mobile edge computing is the result of convergence between mobile network and Internet and it has expectable application prospect.

Mobile edge computing focuses on making full use of the resources of the mobile network and internet of things. Because of diversity and physical decentralization of the resources from mobile edge computing,it is more complicated to organize the resources.

If a network function is planned to be implemented by mobile edge computing, many physical devices and many logical function entities are necessary to cooperate to finish the task. Under many circumstanses, those physical devices or logical entities need to work in order, then, service function chain is good solution for such circumstances.

```
                              (~~~~~~~~~~~~~~~~~~~~~~~~~~)
                             (                            )
                            (                              )
                           (                                )
    +------+              (                                  )
    |Classi| --------->  (              Cloud                 )
    |fier  |              (                                  )
    +------+               (                                )
                            (                              )
                             (                            )
                              (                          )
                               (                        )
                                ~/~~~~~~~~~~~~~~~~~~\~~~
                                 /                   \
                                /                     \
     (~~~~~~~~~~~~~~~~~~~~~~~~~~)        (~~~~~~~~~~~~~~~~~~~~~~~~)
    ( |SF1i| |SFF1j| ...|SF1k|   )     (|SF2i| |SFF2j| ...|SF2k|  )
   (  +----+ +-----+    +----+    )   ( +----+ +-----+    +----+   )
  (            Edge                ) ..(           Edge             )
   (   +----+ +-----+             )    (   +----+  +-----+          )
    (  |SF1m| |SFF1n|  |... |    )      (  |SF2m|  |SFF2n|  |... |)
     (                          )         (                       )
      ~~~~~~~~~~~~~~~~~~~~~~~~~~           ~~~~~~~~~~~~~~~~~~~~~~
```

Figure 7: Logical structure for F-SFC in MEC

As physical devices or logical entities are physically decentralized, it is possible that two or more service function chain are needed to realize a certain network function, then, F-SFC is a appropriate solution.

Figure 7 describes logical structure for F-SFC in MEC. In figure 7, all or partial SFs and SFFs of the service function chain are deployed at the edge. In the meantime, two or more service function chains are dsigned in the mobile network or the network edge. Those service function chains should be merged to a single service function chain.

3.5 F-SFC in Distributed Active/Active Data Center

Another candidate application scenario for F-SFC is active/active data center.

If multiple and distributed data centers are designed and deployed according active/active mode, advantages are obvious. At first, the idleness of a data center is avoided so that network resources can be made full use. Secondly, when one data center is out of order, there is no obvious negative influence to the user of the data center.

When service function chain is applied in active/active data center, F-SFC is also a appropriate solution. It is essential to deploy a single service function chain in every data center. It is not a good design to control and manage the service function chains respectively. So It is a better solution to fuse the service function chains

```
                  |        (~~~~~~~~~~~~~~~~~~~~~~~~)
                  |       (|SFAi| |SFFAj| ...|SFAk|  )
                  |      ( +----+ +-----+    +----+   )
                  |---- (                              )
                  |      (   +----+  +-----+          )
                  |       (  |SFAm|  |SFFAn|  |... | )
 +------+         |        (                        )
 |Classi| ------>|         ~~~~~~~~~~~~~~~~~~~~~~~~
 |fier  |         |
 +------+         |         (~~~~~~~~~~~~~~~~~~~~~~~~~~)
                  |        (|SFBi| |SFFBj| ...|SFBk|    )
                  |       (  +----+ +-----+    +----+    )
                  |----  (                              )
                  |       (   +----+ +-----+             )
                  |        (  |SFBm| |SFFBn|  |... |    )
                  |         (                          )
                  |          ~~~~~~~~~~~~~~~~~~~~~~~~~~
```

Figure 8: Logical structure for F-SFC in Active/Active DC

to form a single service fucntion chain.

Figure 8 describes the logical structure for F-SFC applied in distributed active/active data center.In the figure, there are many SFs and SFFs designed in every data center, F-SFC can fuse those SFs and SFFs with the outside CF to form a integrated service function chain.

3.6 F-SFC in Network Function Virtualization Context

Network function virtualization context is also proper for F-SFC. When a service function chain is deployed in NFV context, SFs and SFFs can be implemented based on VMs(Virtual Machine). VMs can be designed in different servers, so VMs are physically discentralized. On the other hand, a VM can migrate from one server to another, it causes that management of the VMs become more difficult. When SFs or SFFs are realized by VMs, SFs or SFFs would also be discentralized and can be migrated from one server to another, then, organization of a service function chain in NFC context is also difficult.

When it is necessary for two or more service function chains in NFV context to cooperate to realize a network function, it is also not a good design to organize the service function chains seperately. In reality, F-SFC is a better solution under such circumstance.

```
                          +----------+
                          |Classifier|
                          +----------+
                               |
                   ----------------------------
                      |                  |
    +-----------------------------+      +---------------------------+
    |Server A                     |      |Server B                   |
    | +----+ +-----+    +----     |      |+----+ +-----+    +----+  |
    | |vSFi| |vSFFj| ...|vSFk|    |      ||vSFl| |vSFFo| ...|vSFp|  |
    | +----+ +-----+    +----+    |      |+----+ +-----+    +----+  |
    |                             |  ... |                           |
    |  +----+ +-----+  +----+     |      |  +----+  +-----+  +----+ |
    |  |vSFm| |vSFFn|  |... |     |      |  |vSFq|  |vSFFh|  |... | |
    |  +----+ +-----+  +----+     |      |  +----+  +-----+  +----+ |
    |                             |      |                           |
    +-----------------------------+      +---------------------------+
```

Figure 9: Logical structure for F-SFC in NFC

Figure 9 describes such application scenario. In figure 9, SFs are realized by VMs and called vSFs, and SFFs are realized by VMs and called vSFFs. vSFs and vSFFs can be organized to form two or more service function chains. Multiple service fucntion chains can be fused to be a single service chain.

4 Additional Requirements for Fused Service Function Chain

When two or more service function chains are fused to form a single service function chain, there are some new requirements to be taken into account while comparing to the general service fucntion chain.

There are several aspects related to the additional requirements, the following are those aspects:

- Function aspect.

- Performance aspect.

- Control aspect.

- Management aspect.

- Other aspect.

4.1 Function Aspect

Additional functional requirement can be specified as follows:

- F-SFC shall support all capability that every member service function chain can support.

- F-SFC should support flow-control function between adjacent member service function chains.

4.2 Performance Aspect

Additional performance requirement can be specified as follows:

- The throughtoutput of F-SFC is requiremed to be not less than the minimum of throughoutputs of the member service function chains.

- The packet loss rate of F-SFC is requiremed to be not greater than the maximum of packet loss rate of the member service function chains.

4.3 Control Aspect

- F-SFC should support the capability to enable/disable CFs in every member service chain.

- F-SFC should support the capability to re-structure according to the requirement of the specific network funtion.

4.4 Management Aspect

- F-SFC shall support the capability to manage all member service chains unifiedly.

4.5 Other Aspect

- F-SFC should support the capability to aware network context between adjacent member service fucntion chains.

5. Security Considerations

The security considerations described throughout [RFC7665] and [RFC8300] apply here as well.

Additionally, when a data packet is forwarded from SFC(i) to SFC(i+1), the path between SFC(i) to SFC(i+1) should provide mechanism to guarantee security of the data packet.

Moreever, when the CF in SFC(i) is by-passed, it should be assured that the bu-passed path has the same security support as the CF.

6 IANA Considerations

This document has no IANA requirements.

7 Acknowledgements

This document is written by referring to [RFC7665] authored by J. Halpern and C, Pignataro and [RFC8924] authored by S. Aldrin, C. Pignataro, N. Kumar, R. Krishnan and A. Ghanwani.

Many thanks to all the afore-mentioned editors and authors.

8 References

8.1 Normative References

[RFC7665] J. Halpern and C. Pignataro, "Service Function Chaining (SFC) Architecture", RFC 7665, October 2015.

[RFC8300] P. Quinn, U. Elzur and C. Pignataro, "Network Service Header (NSH)", RFC 8300, January 2018.

[RFC8459] D. Dolson, S. Homma, D. Lopez and M. Boucadair "Hierarchical Service Function Chaining (hSFC)", RFC 8459, September 2018.

[RFC8924] S. Aldrin, C. Pignataro, N. Kumar, R. Krishnan and A. Ghanwani, "Service Function Chaining (SFC) Operations, Administration, and Maintenance (OAM) Framework", RFC 8924, October 2020.

8.2 Informative References

[RFC2119] S. Bradner, "Key words for use in RFCs to Indicate Requirement Levels", RFC 2119, March 1997.

[RFC7498] P. Quinn and T. Nadeau, "Problem Statement for Service Function Chaining", RFC 7468, April 2015.

[RFC8393] A. Farrel and J. Drake, "Operating the Network Service Header (NSH) with Next Protocol 'None'", RFC 8393, May 2018.

[I-D.ietf-sfc-multi-layer-oam]   G. Mirsky, W. Meng, B. Khasnabish and C. Wang, "Active OAM for Service Function Chains in Networks", draft-ietf-sfc-multi-layer-oam-07, December 2020.

Authors' Addresses

Jinyou Dai
China Information Communication Technologies Group.
Gaoxin 4th Road 6#
Wuhan, Hubei 430079
China

Email: djy96@sina.com

Xueshun Wang
China Information Communication Technologies Group.
Gaoxin 4th Road 6#
Wuhan, Hubei 430079
China

Email: xswang@fiberhome.com

Jun Gao
China Information Communication Technologies Group.
Gaoxin 4th Road 6#
Wuhan, Hubei 430079
China

Email: jgao@fiberhome.com