                 Hierarchical SFC for DC Interconnection
                 draft-ao-sfc-for-dc-interconnect-01.txt

Abstract

   In a SFC, sometimes some SFs are provided by several DC networks,
   which means these SFs my locates in different DC network . How to
   establish such SFC that is across several DCs is what the draft wants
   to present. In this document, a hierarchical SFC method is proposed.
   It covers data plane, control plane to archieve such hierarchical
   SFC. And it includes requirements of the SFC Gateway for every DC
   network that provide SF for SFC.

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1. Introduction

Service Function Chain (SFC) is the chain with a series of ordered
Service Functions(SF). These SFs are distributed in a DC network or
some DC networks. So it's common that a SFC is across several DC
networks, which incurs the problem of DC network interconnection.
Every part of the SFC in one DC network is a SFC within DC network.
We call such SFC to be hierarchical SFC. And the part of such SFC
within a DC network is called to be Complex SF. Complex SF may
contain one or more SFs that are within one DC network, but is a
logical SF from the view of the hierarchical SFC.

This document is going to describe the architecture for such
scenario. And data plane and control plane will be provided to
specify how the hierarchical SFC works. Meantime, some concepts are
proposed.

2. Terminology

SFC(Service Function Chain): An ordered set of some abstract SFs.

H-SFC(Hierarchical SFC): A SFC that transfers one or more Data center
networks. Every Datacenter network provide a complex SF for H-SFC.

Complex SF: A logical SF that is provided by a SFC in Datacenter network. For H-SFC, the SFC in one Datacenter network is regarded as a complex SF on the path of this H-SFC.

I-SFC(Internal-SFC): A Service Function Chain within the Datacenter network which is corresponding to the complex SF in H-SFC.

SFC-GW: A gateway for SFC in a Datacenter network which is used to interconnect with H-SFC.

3. Architecture of Hierarchical SFC

Hierarchical SFC is composed of an ordered of SFs or Complex SFs. Complex SF is a logic SF that is composed of an ordered of SFs which form a SFC in DC network. The Complex SF is managed by the operator of the DC network. With H-SFC mechanism, we can interconnect every SFC of every Datacenter network as a whole H-SFC.

For the architecture of the H-SFC, please see Figure 1 below. For controller1, it set up a SFC which path is Complex SF#1->Complex SF#2->Complex SF#3.Every Complex SF in such SFC is actually a SFC in datacenter network, and such SFC is set up by the controller in the DC network(Controller2). In the Figure 1, a Complex SF#2 is a SFC which path is SF#21->SF#22. To setup a H-SFC, we need to:

1) To deteremin what kind of service the Complex SF should provide has been determined by the Orchestration;

2) To establish the corresponding SFC in the Datacenter network of the Complex SF has been established by the controller of the Datacenter network;

3) Complex SF also has its SFID in H-SFC;

4) Complex SF as next hop of the H-SFC also has its locator, which may be the address of the SFC-GW. This locator information has been exchanged with Controller1.

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                                          +-------------
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                +-------------+----------------+----+------------------
        +               |
                |             |                     |
        |               |
                |             |              .........|.........
        |               |
                |     +-------------+     . +-------------+ .
        +-------------+             v
                |     |    SFF1     |   . |     SFF2     |. |          SFF3
        |    +----------------+
                |     +-------------+     . +-------------+ .
        +-------------+     |              |
                |             |            .             |          .
        |             | Orchestration  |
                |             |            .             |          .
        |             |                |
                v             v          .             v          .
        v         +----------------+
            +--------+   +---------------+   . +-------------+  .
        +-------------+            ^
          --->|   CF1  |--->| Complex SF#1  |--.--->| Complex SF#2 |--.--->| Complex
        SF#3 |----->      |
            +--------+   +---------------+   . +-------------+  .
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        \                       |
                                  /    | Controller2 |<---
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               /    |   +----------+     +--------+ |      +---------+
+---------+ \
         <=============>|   |  SFC-GW  |---->|   CF2  |-|----->|  SN#21  |----
>|   SN#22 | \
               |    |   +----------+     +--------+ |      +---------+
+---------+   \
               |        +-------^----------------------
+                     |        |
               |
|                                            |        |
               |
+-------------------------------------------------+        |
               |                                 DC
Network                     |

(-----------------------------------------------------------------------------)
```

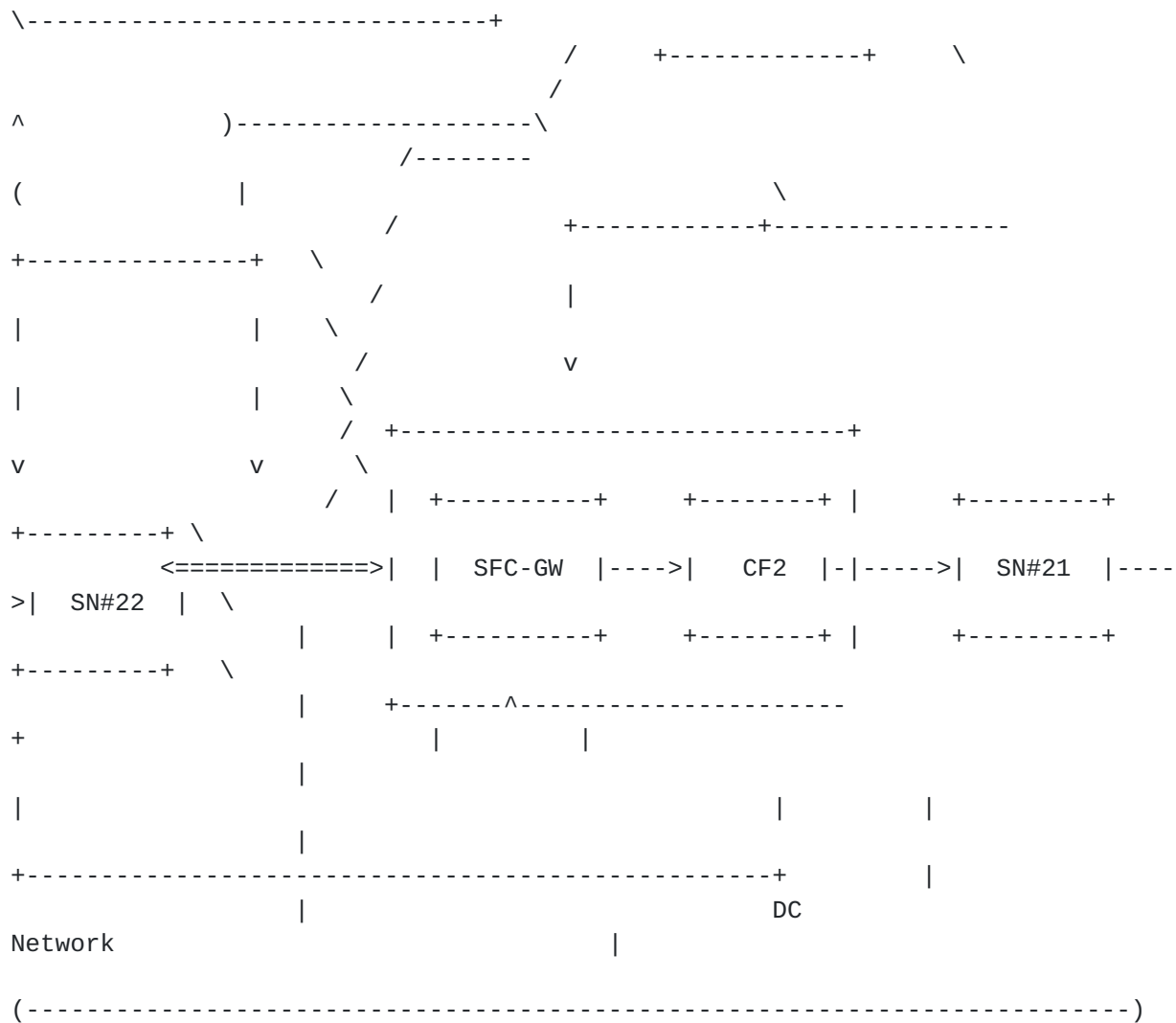   Figure 1 H-SFC architecture

   In the Figure 1, the Complex SF#1, Complex SF#2, Complex SF#3 which
   is provided by a separate Datacenter network are an ordered set of a
   Hierarchical SFC(H-SFC). For this H-SFC, they are logical SFs. But
   for this datacenter network, it's actually a SFC within the
   datacenter network.

CF1 classifies the traffic and assign it a H-SFC. The traffic
traverses along the path according to this H-SFC. Whenever the
traffic enters into Complex SF#n, it actually enters into the
corresponding Datacenter network through SFC-GW to begin its SFC.
The setup of this SFC in the datacenter is invisible to H-SFC. The
path of the SFC in the datacenter network is also invisible to H-SFC.

3.1. SFC-GW

SFC-GW is the component that interconnect the DC networks, and
through which Complex SF#n communicate with H-SFC. For H-SFC, the
SFC-GW can be considered as a SFF for the corresponding Complex
SF#n,see Figure 2. And the SFC-GW's locator is regard as the next
hope address of the HSFC. Traffic enters into Complex SF#n arrives
the SFC-GW firstly, and then is forwarded to the Classifier in
Datacenter network by the SFC-GW .

When the traffic finishes this SFC in the Datacenter network, it
should be forwarded back to SFC-GW, and then be forwarded to next SF
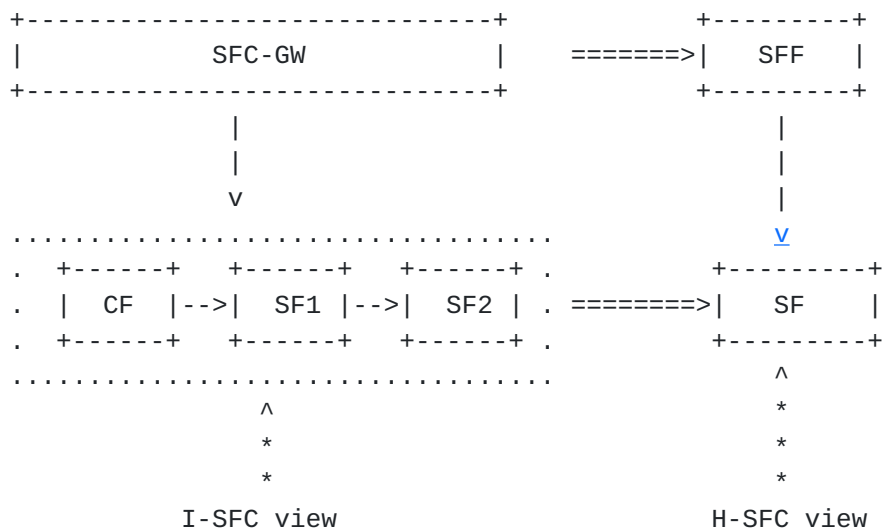or Complex SF by the SFC-GW.

```
        +-------------------------------+           +---------+
        |            SFC-GW             |    =======>|   SFF   |
        +-------------------------------+           +---------+
                    |                                     |
                    |                                     |
                    v                                     |
        ...................................              v
        .  +------+   +------+   +------+ .           +---------+
        .  |  CF  |-->|  SF1 |-->|  SF2 | . =======>|   SF     |
        .  +------+   +------+   +------+ .           +---------+
        ...................................              ^
                       ^                                 *
                       *                                 *
                       *                                 *
                    I-SFC view                      H-SFC view
```
          Figure 2 View of the SFC-GW

3.2. Classifier for Complex SF

Classifier for Complex SF receives the traffic from SFC-GW. For the
traffic, the Classifier classifies the traffic and maps the traffic
into corresponding I-SFC in the Datacenter network according to the
H-SFC header information. The Classifier assigns the traffic the SFC
header and the traffic is forwarded alone the SFP specified by the
SFC header.

4. Encapsulation

   As description in section 3, SFC in Datacenter network is invisible
   to H-SFC. So it's not feasible to use the forwarding method of SFC
   that is in one Datacenter network. We need to assign a new SFC
   header for the specific SFC in the Datacenter network.

   Here is the analysis for the methods to handle the SFC in the
   Datacenter network.

4.1. Overlap SFC encapsulation

   When the packets with H-SFC header arrives the Classifier in the
   Datacenter network, this Classifier would assign a new I-SFC header
   based on the H-SFC header. An example is showed like the following
   format, Figure 3.

```
                       +------------------+
                       | Overlay Header   |
                       +------------------+
                       | I-SFC Header     |
                       +------------------+
                       | H-SFC Header     |
                       +------------------+
                       | Original Packet  |
                       +------------------+
                       Figure 3 View of the SFC-GW
```

   The traffic with the above 2 layer-SFC header would be forwarded
   according to the I-SFC header in the Datacenter network. H-SFC
   header is just preserved in the packets. At the last SFF of the
   Service Function Chain of the network, the I-SFC header is removed
   from the packet and then the packet is forwarded to the SFC-GW of the
   Datacenter network for further forwarding based on the H-SFC header.

   With such encapsulation, H-SFC information is carried along the the
   whole H-SFC life without modification, so that the last SFF in the
   Datacenter center of the I-SFC is not required to be aware of the
   H-SFC. This forwarding method eliminates the last SFF's awareness of
   the H-SFC.

4.2. Metadata SFC encapsulation

   In this method, H-SFC header is transferred as a metadata that is
   stored in the I-SFC header. And at the last SFF of the I-SFC, the
   SFF need to restore metadata information into H-SFC header, then pass
   such traffic to SFC-GW.

This method requires that the last SFF must transfer I-SFC header to H-SFC header before forward the traffic to SFC-GW.

4.3. Exchange SFC encapsulation

In this kind of encapsulation, there is 1 layer SFC header with the packet all the time. The Classifier in the Datacenter network maps the H-SFC header to the I-SFC header. And the last SFF of the I-SFC maps the I-SFC header back to H-SFC header.

This method requires the last SFF in Datacenter networknot only map the I-SFC header back to H-SFC, but also must learn the mapping information from controller.

5. Coordination

5.1. Controllers

To make sure that the H-SFC and I-SFC can work coordinately, Controller1 in Figure 1 and Controller2 should communicate each other.

a. Controller2 setup Internal Service Function Chain(I-SFC) corresponding to Complex SF provided to H-SFC. The service the Complex SF provides is communicated between Controller1 and Controller2.

b. Once Controller1 get the information of Complex SF, Controller1 setup the Hierarchical SFC. Furthermore, Controller1 need to get SFC-GW locator as next hop address of the H-SFC.

c. The relationship between H-SFC and I-SFC, especially SPFID, Index, etc information.

5.2. Controller to Classifier

d. Sometimes, the classifier policy in DC network may also take considerate of SFPID in H-SFC.

5.3. Controller to SFF

e. For each Complex SF, controller2 should tell the last SFF of the I-SFC that the next hop is SFC-GW, so that the traffic can be forwarded to such SFF after the process of the complex SF.

[6](#). **Summary**

   As we discuss above, H-SFC is very useful in the Service Function
   Chain across several Datacenter networks so that the SFC is more
   scalability. With the overlap SFC encapsulation, we keep the
   principle that the two level SFC decouple as possible as it can. And
   we can use the existing SFC in Datacenter to be a Complex SF without
   modification and with no new requirement for SFF.

[7](#). **Security Considerations**

   To be added later

[8](#). **IANA Considerations**

   N/A

[9](#). **Information References**

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