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J. Lan
Y. Hu
G. Cheng
P. Wang
T. Duan
NDSC P.R. China
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Service Function Path Establishment
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Abstract

Service Function Chain architecture leads to more adaptive network nodes. It allows splitting the network function into fine-grained build blocks --- service function, and combining the network functions into service function chain to formulate complicated services. Further, the service function chain should be instantiated by selecting the optimal instance from the candidates for each service function in it. This document discusses the required components during the instantiation of service function chain in the network.

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1. Introduction

The end-to-end services delivery often present various demands for different functions including the traditional functions and diversified novel ones such as application-specific features. However, the rigidly fixed model of service function in the legacy network chain lacks in adaptability for that circumstance. It cannot fulfill the current various requirements of end users or applications, such as cross layer in the wireless network.

Accordingly, service function chain is provided to enhance the network flexibility and adaptability. It consists of several service functions in a special order that the corresponding packets or flows should drill through them. The network administrative entity could "insert" or "disable" a service function in the service function chain based on the new dynamic demands.

Service function chain architecture splits the network functions into finer-grained service functions. It then decouples the service functions from the underlying physical topology, and enables the new placement and combination of service functions viable. In the SFC-enabled domain, many service function instances will co-exist provided by different vendors. Before SFC deploys to delivery packets or flows, it must be instantiated by selecting instances distributed in the network for each service functions.

This document outlines the required components regarding to the service function path including the establishment, deletion, modification/update based on the policy.

2. Conventions used in this document

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](#)].

3. Terminology and Abbreviations

3.1. The Terminology

This document uses the terminology defined in the SFC Problem Statement [[I-D.quinn-sfc-problem-statement](#)] and the SFC Framework & Architecture [[I-D.boucadair-sfc-framework](#)]. Additional terminology is defined below:

Service Function Instance: A Service Function Instance locating in a service node deals with the specific packets based on the function

logic declared.

Service Function Path: The Service Function Path is the instantiation of a service function chain in the network. It consists of the service function instances in the service function chain.

Service Information Base: A Service Information Base is a data structure tracking the information about the service functions. It must include the location of service functions, service type (e.g., load balancer, firewall), and managed information such as the load, capacity and current status of service function. SIBs may be configured and managed by the administrative entity that operates the SFC-enabled domain. SIBs also may be automatically updated by the service function discover. In the distributed mode, SIB's replicas could be distributed over the SFC-enabled domain.

Topology Information Base: A Topology Information Base stores the Physical network infrastructure topology. Its replicas can be placed in the same network node with SIB, or in a separate one. In the distributed mode, TIB's replicas could be distributed over the SFC-enabled domain.

SFP-enabled Management Entity: SFP-enabled Management Entity is responsible for the establishment, deletion, modification/update of SFPs for various SFC.

3.2. Acronyms and Abbreviations

SFI	Service Function Instance
SFP	Service Function Path
SIB	Service Information Base
TIB	Topology Information Base
SFP-ME	SFP-enabled Management Entity
SFPS	Service Function Pre-Selection
SFPC	Service Function Path Calculation
SCPB	Service Chain-Path Base

4. Core components for SFP

The establishment of a SFP which consists of multiple service functions (SFs), needs to select one service function instance (SFI) from multiple SFIs distributed in the network for each service function. To make decision, service function (SF) node information and underlying topology information need to be collected automatically and periodically. The following sections describe the framework and data structures to store SF information and topology information for the establishment of SFP.

4.1. Framework

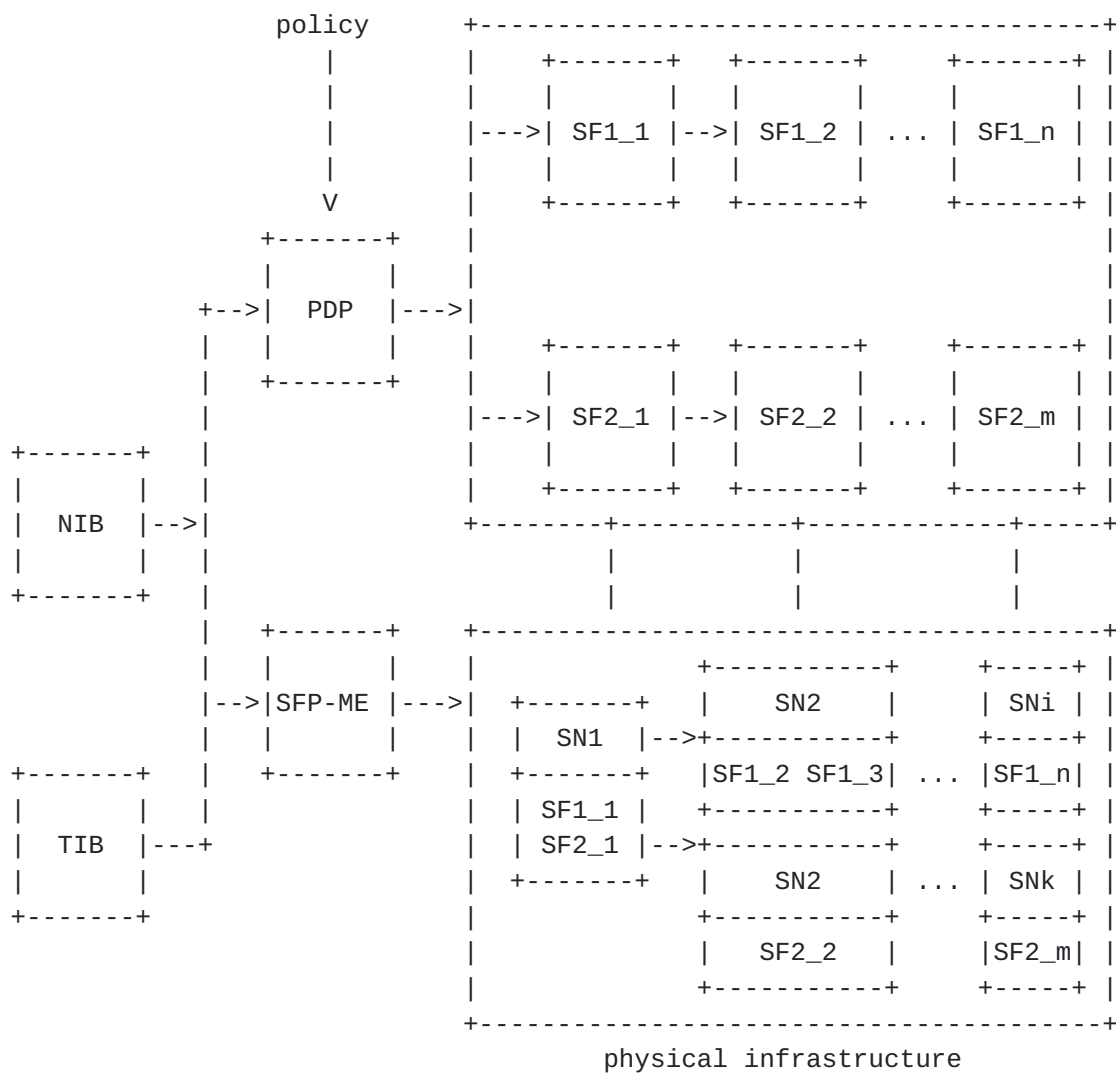


Figure 1 Core components for SFP establishment

As shown in figure 1, the core components of SFP include PDP, SFP-ME, SF information base (SIB), and topology information base (TIB). As

defined in [I.D- boucadair-sfc-framework], the PDP is the central entity which is responsible for maintaining SFC policy Tables, and enforcing appropriate policies in SF nodes and SFC Boundary Nodes. In addition, the PDP in this document is also responsible for creating SFCs according to the requirements of applications or profits of vendors. The SIB stores the SF information which includes SF identity, SF locator, SF type, SF capacity, SF load and SF status. SF information can be collected from SFC-enabled domain by using IGP or BGP-LS [I.D-draft-idr-ls-distribution]. The TIB is used to store underlying physical network infrastructure topology information which can be collected from network by using IGP or BGP-LS [I.D-draft-idr-ls-distribution]. The SFP-ME is responsible for establishing, deleting, and modified SFP according to SFC made by PDP, SF information, and topology information. The SFP-ME is also responsible for SFP management.

4.2. SIB structure

The SF information stored by SIB is used to establish or update SFP by SFP-ME. The SIB structure is defined in Fig.2. The following entries are defined in the SIB.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|Index|SF identity|SF locator|SF type|SF capacity|SF load|SF status|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Figure 2 SIB structure

Index: denotes the sequence that a SF entry locates in the SIB. The index can be used to lookup the SF entry quickly.

SF identity: is used to identify the SF and is unique in SFP-ME enabled domain. Each SF has an unique identity. The service function server is responsible for the SF identity management and allocation.

SF locator: represents the SF node where the SF locates. The SF locator is non-exclusive. Multiple SFs could locate in one SF node or multiple different SF nodes.

SF type: denotes the type of a SF. SFs can be classified into different classes which include firewall, DPI (Deep Packet Inspection), load balancer, etc. The definition of SF can refer to [I.D- boucadair-sfc-framework]. In this document, the SFs may be service functions in layer 3 or service functions in layer 4-7.

SF capacity: represents the capacity to process the traffic. The same service function may have multiple service functions in different capacities.

SF load: denotes the current traffic load steering a SF. The SFP-ME can establish or update SFP according to SF load.

SF status: denotes the current status of a SF. The SF status includes available, congestion, unavailable, etc. The exact definition of SF status is application-specific.

4.3. TIB structure

The underlying physical network topology information is used to deploy SFs for establishing or updating SFP according some optimal criterions or the profit of vendors. The TIB is used to store network topology information. The structure of TIB can be defined in different formats, e.g. routing information table etc. Fig. 3 shows a definition of the TIB structure. The following entries are defined in the TIB.

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| SF node | number | Neighbor 1 | Neighbor 1 |...| Neighbor N |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Figure 3 TIB structure

SF node: denotes the SF node which reports the information. The identifier of SF node can be flat identifier or hierarchical identifier, e.g. IP address.

Number: denotes the number of neighbor nodes.

Neighbor: denotes the neighbor node of the current SF node. A SF node may have multiple neighbor nodes.

5. SFP management

SFP aims to provide SFC an optimal/near-optimal path on underlying physical network, ensuring network function represented by the specific SFC can be implemented with required or even higher performance. Operations of SFP refer to establishment, deletion and update and are conducted by SFP-ME.

The SFP-ME in this document includes a service function pre-selection (SFPS), classifier, service function path calculation (SFPC) and service chain-path base (SCPB), as shown in Figure 4. The SFPS is used to select candidate nodes for SFP establishment. The classifier is used to determine which cost function is taken for SFP establishment and transfer SFP deletion and update information to SFPC. The SFPC is used to fulfill SFP establishment, deletion and

update. The SCPB stores service function chain-path mapping information and is used for SFP deletion.

A service function path header should be added to encapsulated packets or frames to represent service function paths. The service function path header should be independent of the underlying transport and can be encapsulated inside any transport mechanism. There are several approaches to encapsulate service function path header as described in Metadata Considerations [I-D.rijsman-sfc-metadata-considerations], Service Chain Header [[I-D.zhang-sfc-sch](#)], Network Service Header[I-D.quinn-sfc-nsh] and so on.

To implement SPF establishment, deletion and update, SFP-ME need to interact with NIB, TIB, PDP by using a variety of protocols, such as NETCONF [[RFC6241](#)], PCEP[I-D.wu-pce-traffic-steering-sfc], etc.

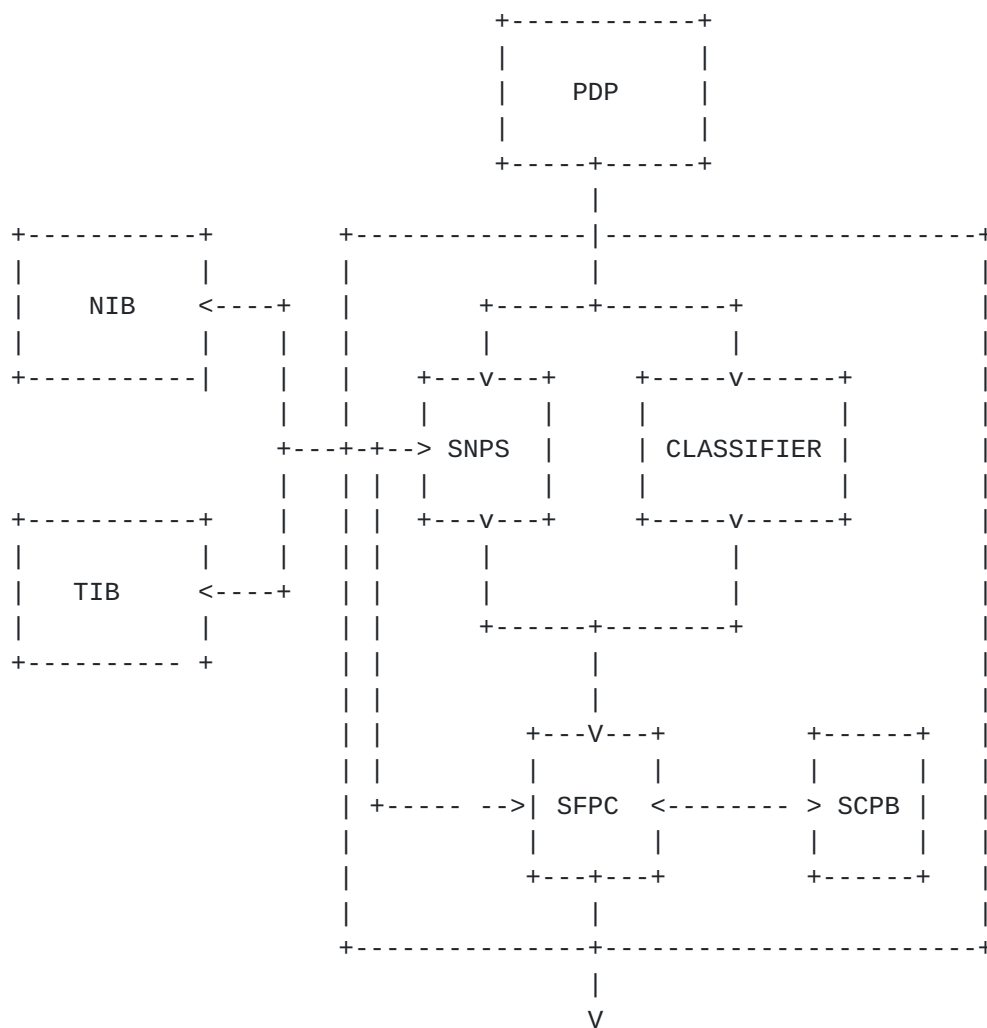


Figure 4 Framework of SFP-ME

5.1. SFP establishment

SFP establishment refers to determining the optimal/near-optimal service node for each service function on SFC and finding the optimal/near-optimal path for the instantiated service nodes of a given SFC such that the required service functions are executed in sequence required by SFC with minimal costs.

The term of cost is user-defined and can be end-to-end delay, resource consumption and so on. There may exist only one cost definition which can be applied to all SFC in the same domain, or may co-exist several different cost definitions with each one targeting at different types of SFC. Cost must be expressed as a function, i.e. cost function. Trying to minimize the cost, several algorithms can be applied based on different cases.

When SFC is generated based on policy in PDP, SFP-ME receives SFC information and start to execute SFP establishment. The SFP establishment processes in three steps, as shown in Figure 5.

Firstly, SNPS selects several service nodes as candidates, these service nodes must include one or more service function Instance of the given SFC and are currently available. Concurrently, classifier selects the appropriate cost function according to the type of the given SFC, this step can be omitted if there is only one cost function applied to all SFC in the same domain.

Secondly, with the aim to minimize cost, SFPC applies algorithms to selects one service node for each service function of the given SFC from the candidates and builds a path making the service functions strictly executed with the ordered sequence. Thus an optimal/near-optimal SFP for SFC is established.

Lastly, Information of the established SFP is send to SFC entrance, meanwhile SCPB is updated.

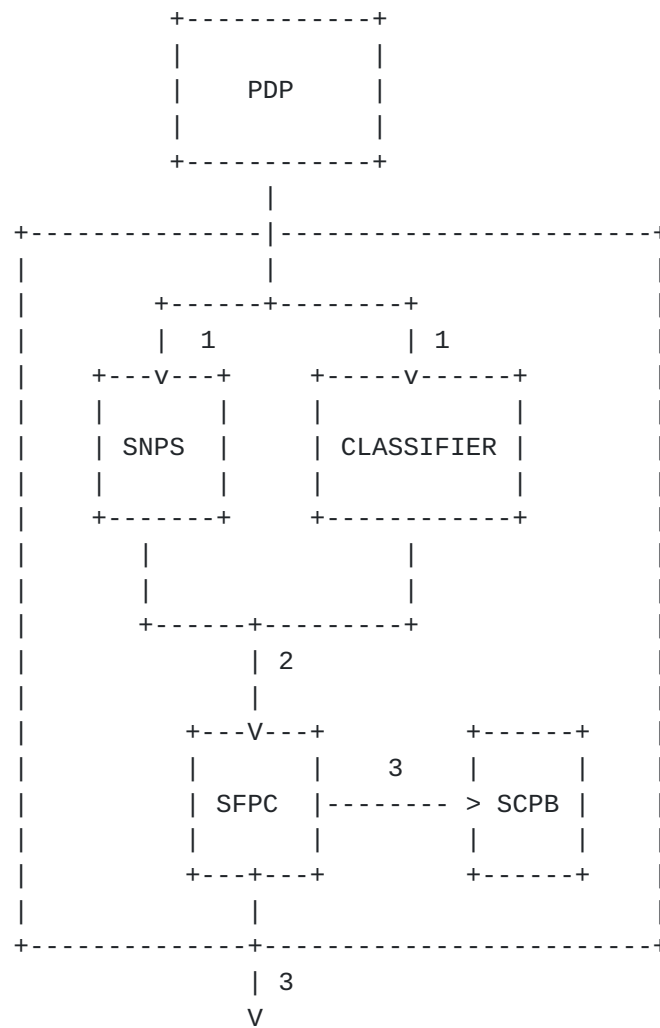


Figure 5 SFP Establishment Process

5.2. SFP deletion

SFP deletion refers to releasing the overall service function Instantiations of the established SFP, thus the released service function Instantiations can be used for other SFP's establishment.

SFP-ME starts to execute SFP deletion once PDP notifies that SFC has been deleted. Information of the to be deleted SFC is send to SFPC through classifier and match against the restored SFC in SCPB to find SFP for the given SFC, then SFPC notify SFC entrance that this specific SFP is invalid, meanwhile update SCPB. The SFP deletion process is shown in Figure 6.

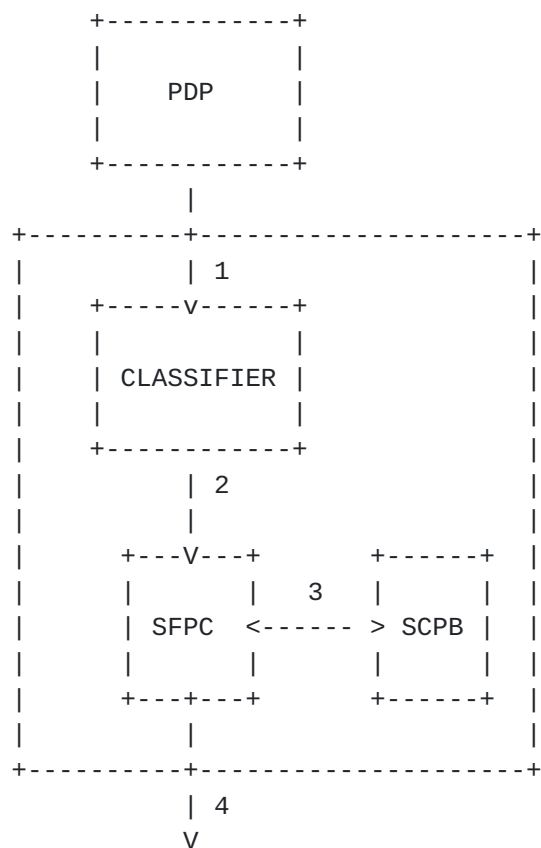


Figure 6 SFP deletion process

5.3. SFP update

SFP update refers to changing partial service function Instantiations or path of the established SFP, due to breakdown of partial service function nodes or physical links.

Breakdown of service function nodes or physical links can lead the established SFP to work improperly, re-establishment of SFP can be executed to guarantee function of the corresponding SFC is still implemented with optimal/near-optimal performance. SFP update is an alternative way. The updated SFP may perform worse than the re-establishment one, however, the update process takes up less time which can be very attractive to time-sensitive function.

SFP-ME starts to execute SFP update once PDP notifies that SFP need to be updated. Information of the to be updated SFC is send to SFPC through classifier, SFPC selects adjacent service nodes or path to replace the ones which has been breakdown. Thus the given SFP is undated, Information of the undated SFP is send to SFC entrance. The SFP update process is shown in Figure 7.

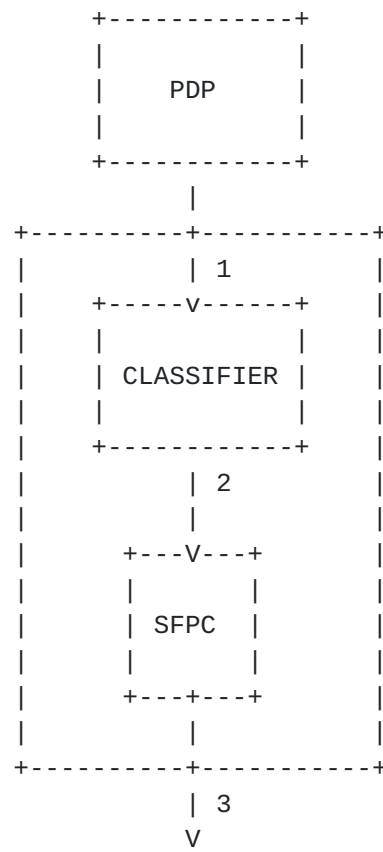


Figure 7 SFP update process

6. Security Considerations

It will be considered in a future revision.

7. IANA Considerations

No IANA action is needed for this document.

8. References

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Authors' Addresses

Julong Lan
National Digital Switching System Engineering and Technological
Research Center
NDSC
Jianxue Ave. No. 7
Zhengzhou 450002
China

EMail: ndscljl@163.com

Yuxiang Hu
National Digital Switching System Engineering and Technological
Research Center
NDSC
Jianxue Ave. No. 7
Zhengzhou 450002
China

EMail: chxachxa@126.com

Guozhen Cheng
National Digital Switching System Engineering and Technological
Research Center
NDSC
Jianxue Ave. No. 7
Zhengzhou 450002
China

EMail: chengguozhen1986@163.com

Peng Wang
National Digital Switching System Engineering and Technological
Research Center
NDSC
Jianxue Ave. No. 7
Zhengzhou 450002
China

EMail: wangpeng.ndsc@gmail.com

Tong Duan

NDSC

Jianxue Ave. No. 7

Zhengzhou 450002

China

EMail: duantong21@126.com