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R. Parker
Affirmed Networks

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Service Function Chaining: Chain to Path Reduction
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Abstract

The service function chaining concept differentiates between a service function chain and a service function path. A chain is a sequence of service function types whereas a path is a sequence of service function instances that realize each type of service function.

This document describes the architectural approach to reducing the abstract service function chain to the concrete service function path.

Table of Contents

1. Introduction....3
1.1. Service Function Chaining Concepts....3
1.2. Scope....3
1.3. Objectives....4
1.4. Rationale....4
2. Conventions used in this document....4
3. New SFC Functional Entities....6
3.1. SFC Proxy....6
3.1.1. SFC Proxy for Non-last Service Function....6
3.1.2. SFC Proxy for Last Service Function....6
3.2. Service Function Load Balancer....6
3.2.1. Proxy Service Function Load Balancer....7
4. Service Function Path Topologies....7
4.1. Chain Comprised of Singly-located Service Functions....7
4.1.1. With Non-SFC-aware Service Functions....7
4.2. Chain Comprised of Multiply-located Service Functions....8
4.2.1. With Non-SFC-aware Service Functions....9
4.3. Hybrid Chains....9
5. Security Considerations....10
6. IANA Considerations....10
7. Conclusions....10
8. References....11
8.1. Normative References....11
8.2. Informative References....11
9. Acknowledgments....11

1. Introduction

1.1. Service Function Chaining Concepts

The service function chain is an abstract sequenced set of service functions, as described in [I-D.boucadair-sfc-framework]. Service functions that participate in SFC are assumed to be transparent "midbox" service functions, where transparent in this usage denotes only that the service function is not explicitly addressed by either communications endpoint.

The service function locator, also described in [I-D.boucadair-sfc-framework], is the means to bind the abstract service functions to physical or virtual instantiations. The completed mapping of a service function chain through the locators of its constituent service functions is called a service function path, also described in [I-D.boucadair-sfc-framework].

A service function may have a single locator, or multiple locators. When multiple locators are specified, a load balancing operation is required to select which one of the instances shall be used for any particular service function path. This document describes an approach where the service function path is rendered in real time, on a packet by packet basis, from the service function chain.

1.2. Scope

This document defines a technique whereby service function chains may be rendered in real time as service function paths. This document does not make any assumptions regarding the behavior of any particular service function or the appropriate technique (i.e., stateless, stateful, etc.) to load balance for a given service function.

Load balancing across multiple locators may involve liveness checking or load checking. No assumptions are made regarding the appropriate technique to determine the liveness or load for a particular service function. Such load balancing may also involve

other policies, such as location of the service function instance relative to the location of one or both communication endpoints. No assumptions are made regarding the use or type of policy to perform load balancing for a service function.

1.3. Objectives

- SFC classifier (PDP) actions identical for SFC-aware and non-SFC-aware service functions
- SFC classifier (PDP)_actions identical for singly-located and multiply-located service functions
- SFC classifier (PDP) actions identical for any service function
- Preceding service function actions identical for SFC-aware and non-SFC-aware succeeding service functions
- Preceding service function actions identical for singly-located and multiply-located succeeding service functions
- Preceding service function actions identical for any succeeding service function
- SFC does not specify or limit mechanisms and behaviors for load balancing within a service function

1.4. Rationale

SFC proxy functionality for non-SFC aware service functions and load balancing for multiply-located service functions (SFC-aware and non-SFC-aware) belongs to the service function domain. It is not possible nor is it desirable to specify, in a practical manner, either proxy functionality or load balancing for any arbitrary service function.

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].

In this document, these words will appear with that interpretation only when in ALL CAPS. Lower case uses of these words are not to be interpreted as carrying RFC-2119 significance.

In this document, the characters ">>" preceding an indented line(s) indicates a compliance requirement statement using the key words listed above. This convention aids reviewers in quickly identifying or finding the explicit compliance requirements of this RFC.

An abstract service function (i.e., part of a service chain definition) is denoted as '<F>'.

A concrete service function instance (i.e. a service function that has been located) is denoted as '<F>.<n>'.

An SFC service function proxy, as will be defined later in this document, is denoted as '<F>.p'.

A service function load balancer is denoted as '<F>.lb'.

A combined service function load balancer and proxy, as will be defined later in this document, is denoted as '<F>.plb'.

Unless otherwise specified, the term "Service Function Chain" shall be more broadly interpreted as "Service Function Graph". It is understood that any service function may include a reclassifier (i.e., Policy Decision Point) in order to make dynamic branching decisions along the service function graph.

3. New SFC Functional Entities

The following SFC functional entities are in addition to those identified in [I-D.boucadair-sfc-framework].

3.1. SFC Proxy

An SFC proxy front-ends a legacy service function that is not SFC-aware.

3.1.1. SFC Proxy for Non-last Service Function

When receiving packets from the preceding service function (or the PDP if this service function is first), the SFC proxy terminates both the transport and SFC service headers. The resulting packets are forwarded to the legacy service function. The legacy service function must be provisioned to return the packets back to the SFC proxy.

When receiving returned packets from the legacy service function, the SFC proxy generates appropriate transport and SFC service headers towards the succeeding service function.

It is permissible for an SFC Proxy to also act as a reclassifier, thereby making a branching decision on a service function graph.

3.1.2. SFC Proxy for Last Service Function

It shall be an implementation decision as to whether a non-SFC-aware service function that is the last service function in the chain returns the packets to its proxy or send the packets beyond the end of the chain directly.

3.2. Service Function Load Balancer

A service function load balancer manages all load balancing duties for its constituent SFC-aware service function instances. How this is accomplished for the given service function is completely outside the scope of this document.

The service function load balancer appears to preceding services, or the PDP if the service function is the first in the chain, as a single entity that receives all traffic for that service function within the particular chain. Thus, preceding services and the PDP, itself, never concern themselves with the fact that the succeeding service may have multiple locators.

Since the service function load balancer is managing SFC-aware service function instances, it is not, itself eligible to be a reclassifier (Policy Decision Point).

3.2.1. Proxy Service Function Load Balancer

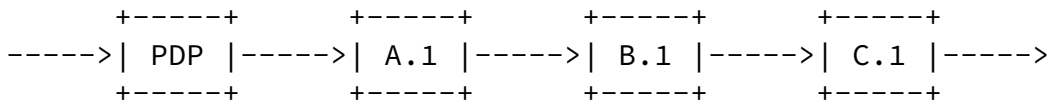
The proxy service function load balancer is a combination of the service function proxy and the SFC-aware load balancer. Since it terminates the transport and SFC service headers, the proxy service function load balancer is eligible to be a reclassifier (Policy Decision Point).

4. Service Function Path Topologies

This section provides a number of example topologies that demonstrate the real-time reduction of the service function chain to a specific service function path.

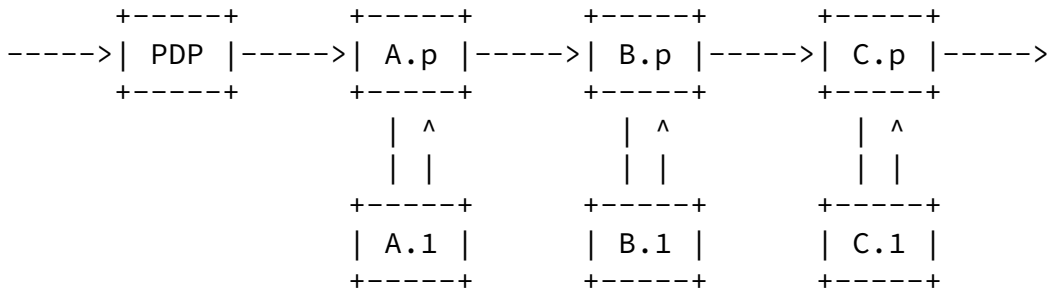
4.1. Chain Comprised of Singly-located Service Functions

This topology is the simplest since the chain and path have a 1:1 correspondence. An example service function path comprised solely of singly-located, SFC-aware service functions is depicted below.



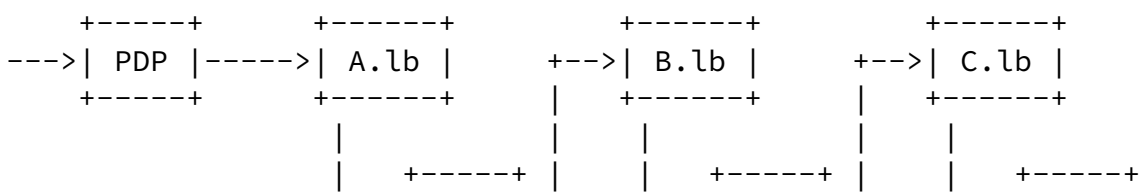
4.1.1. With Non-SFC-aware Service Functions

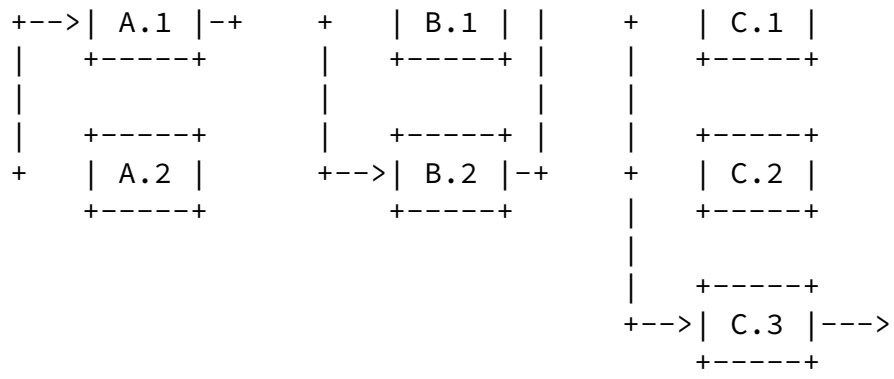
In this use case, the service functions require an SFC-proxy to act as front-end.



4.2. Chain Comprised of Multiply-located Service Functions

This use case supports load balancing across multiple service function instances. For clarity, each load balancer is shown as having picked a particular service instance. The means by which this selection is made is outside the scope of this document.

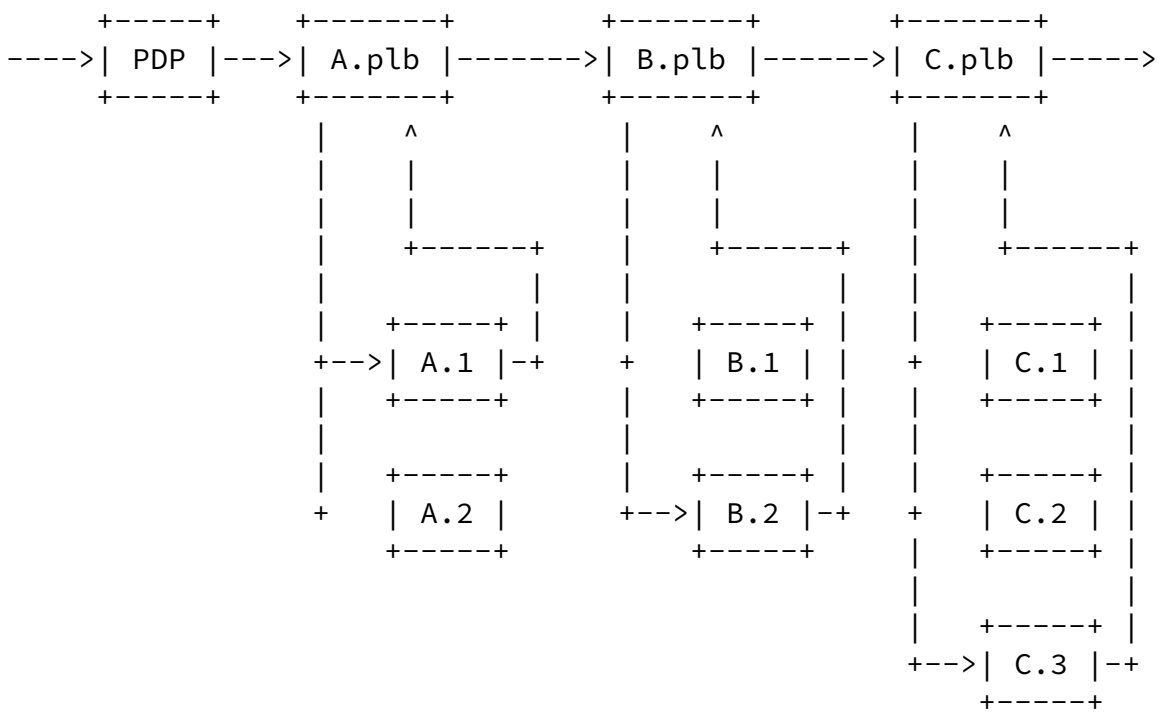




As can be seen from this diagram, the preceding node (PDP or service function) always propagates packets to the responsible load balancer for the next service function in the chain. The load balancer makes a service function appropriate selection for the packet and forwards to one of the service function instances. Since the service function instances are SFC-aware, they directly forward the packet to the next service function load balancer, or out of the chain entirely, if the last service function in the chain.

4.2.1. With Non-SFC-aware Service Functions

This use case could be achieved by front-ending each service instance with an SFC proxy. Such an approach is entirely valid. However, an alternative approach is also supported by use of the proxy service function load balancer.



It can be seen that this diagram differs from the previous in that the service functions must return the packets to their respective proxy/load balancer for appropriate transport and SFC service header encapsulation.

4.3. Hybrid Chains

A chain of service functions may support any combination of service functions that are singly-located SFC-aware, load-balanced SFC-aware, singly-located proxied, and load-balanced proxied.

5. Security Considerations

All SFC entities must be protected against DDoS attacks, malformed

packets, and poorly configured (deliberately or not) service chains and service function locator tables.

6. IANA Considerations

There are no IANA considerations for this document.

7. Conclusions

By strictly layering SFC chaining, SFC proxy, and load balancing, a simpler more resilient end-to-end service function chaining architecture is achieved. Handling of failed service function instances as well as static and dynamic expansion and contraction of the service function is localized to an entity that has been designed specifically for that type of service function.

Both preceding service functions (or PDP) and succeeding service functions are completely unaware of whether a service function is SFC-aware, multiply instantiated, both, or neither.

This architecture provides a unified approach for incorporation of multiple instances of SFC-aware service functions, for incorporation of non-SFC-aware legacy service functions, and for incorporation of multiple instances of non-SFC aware legacy service functions.

8. References

8.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

8.2. Informative References

[I-D.boucadair-sfc-framework]
M. Bouadair, C. Jacquenet, R. Parker, D. Lopez, J. Guichard, C. Pignataro, "Service Function Chaining: Framework & Architecture", http://tools.ietf.org/html/draft-boucadair-sfc-framework-00 (work in progress), October 3, 2013

[I-D.quinn-sfc-nsh]
P. Quinn, et. al., "Network Service Header", http://tools.ietf.org/html/draft-quinn-sfc-nsh-00 (work in progress), October 7, 2013

9. Acknowledgments

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Authors' Addresses

Ron Parker
Affirmed Networks
Acton, MA 01720
USA

Email: ron_parker@affirmednetworks.com