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# SFC OAM for path consistency
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## Abstract

Service Function Chain (SFC) defines an ordered set of service functions (SFs) to be applied to packets and/or frames and/or flows selected due to classification. SFC Operation, Administration and Maintenance can monitor the continuity of the SFC, i.e., that all SFC elements are reachable to each other in the downstream direction. But SFC OAM must support verification that the order of traversing these SFs corresponds to the state defined by the SFC control plane or orchestrator, the metric referred to in this document as the path consistency of the SFC. This document defines a new SFC active OAM method to support SFC consistency check, i.e., verification that all elements of the given SFC are being traversed in the expected order.

## Status of This Memo

Table of Contents



## 1. Introduction

Service Function Chain (SFC) is a chain with a series of ordered Service Functions (SFs). Service Function Path (SFP) is a path of a SFC. SFC is described in detail in the SFC architecture document [RFC7665]. The SFs in the SFC are ordered, i.e., only when an SF processes traffic, then it can be processed by the next SF. Changes in the order are very likely to cause errors. That's why an operator needs to ensure that the order of traversing the SFs is as defined by

the control plane or the orchestrator. This document refers to the correlation between the state of the control plane and the SFP itself as the SFP consistency. The need to verify the consistency of the particular SFP, using a mechanism of an active OAM protocol, is noted in [RFC8924].

This document defines the method to check the path consistency of the SFP. It is an extension of the SFC Echo-request/Echo-reply specified in the [I-D.ietf-sfc-multi-layer-oam].

## 2. Conventions used in this document

### 2.1. Acronyms

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

SFF: Service Function Forwarder

SF: Service Function

OAM: Operation, Administration and Maintenance

SFP: Service Function Path

COAM: Consistency OAM, OAM that can be used to check the consistency of the Service Function Path.

MAC: Message Authentication Code

### 2.2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

## 3. Consistency OAM: Theory of Operation

Consistency OAM (COAM) uses two functions: COAM Request and COAM Reply. Every SFF that receives the COAM Request MUST perform the following actions:

* Collect information of the traversed by the COAM Request packet SFs and send it to the ingress SFF as COAM Reply packet over IP network [I-D.ietf-sfc-multi-layer-oam];

* Forward the COAM Request to the next downstream SFF if the one exists.

As a result, the ingress SFF collects information about all traversed SFFs and SFs, information on the actual path the COAM packet has traveled. That information is used to verify the SFC's path consistency. The mechanism for the SFP consistency verification is outside the scope of this document.

### 3.1. COAM packet

Consistency OAM introduces two new types of messages to the SFC Echo Request/Reply operation defined in [I-D.ietf-sfc-multi-layer-oam] with the following values detailed in Section 5.1:

* TBA1 - COAM Request

* TBA2 - COAM Reply

Upon receiving the COAM Request, the SFF MUST respond with the COAM Reply. The SFF MUST include the SFs information, as described in Section 3.3 and Section 3.2.

The COAM packet, defined in [I-D.ietf-sfc-multi-layer-oam], is displayed in Figure 1.

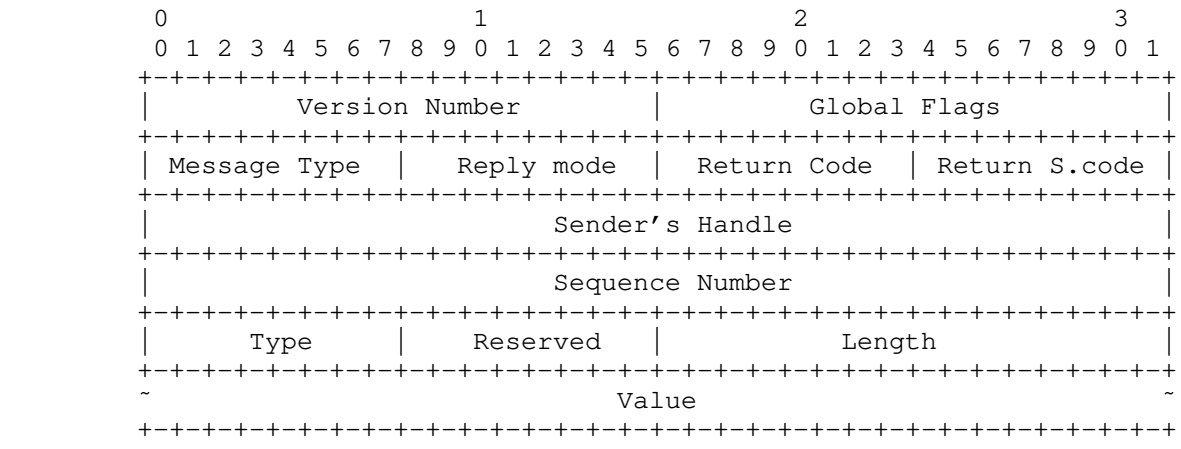

Figure 1: COAM Packet Header

The initiator of COAM Request MAY require the collected information in the COAM Reply be sent in the integrity-protected mode using the a Message Authentication Code (MAC) Context Header, defined in [I-D.ietf-sfc-nsh-integrity]. If the NSH of the received SFC Echo Reply includes the MAC Context Header, the authentication of the packet MUST be verified before using any data. If the verification fails, the receiver MUST stop processing the SFF Information Record TLV and notify an operator. Specification of the notification mechanism is outside the scope of this document.

## 3.2. SFF Information Record TLV

For COAM Request, the SFF MUST include the Information of SFs into the SF Information Record TLV in the COAM Reply message. Every SFF sends back a single COAM Reply Message, including information on all the SFs attached to the SFF on the SFP as requested in the COAM Request message.

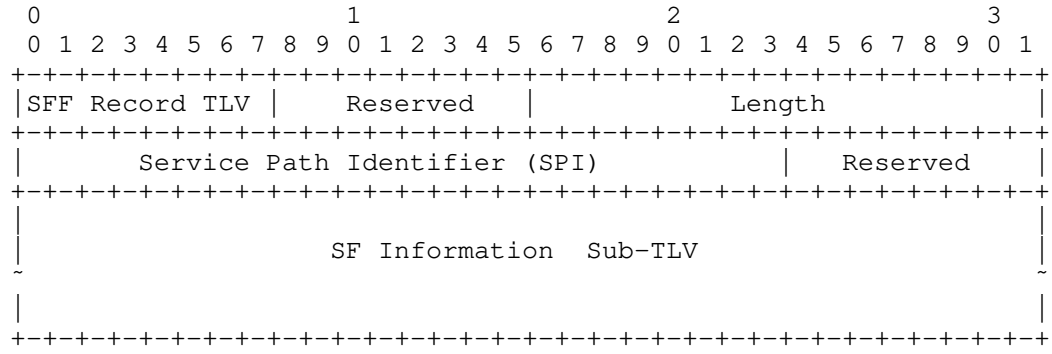


Figure 2: SFF Information Record TLV

SFF Information Record TLV is a variable-length TLV that includes the information of all SFFs mapped to the particular SFF instance for the specified SFP. Figure 2 presents the format of an SFC Echo Request/ Reply TLV, where fields are defined as the following:

Reserved - one-octet-long field.

Service Path Identifier (SPI): The identifier of SFP to which all the SFs in this TLV belong.

SF Information Sub-TLV: The Sub-TLV is as defined in Figure 3.

## 3.3. SF Information Sub-TLV

Every SFF receiving COAM Request packet MUST include the SF characteristic data into the COAM Reply packet. The data format of an SF sub-TLV, included in a COAM Reply packet, is displayed in Figure 3.

After the COAM Request message traverses the SFP, all the information of the SFs on the SFP is collected from the TLVs included in COAM Reply messages.

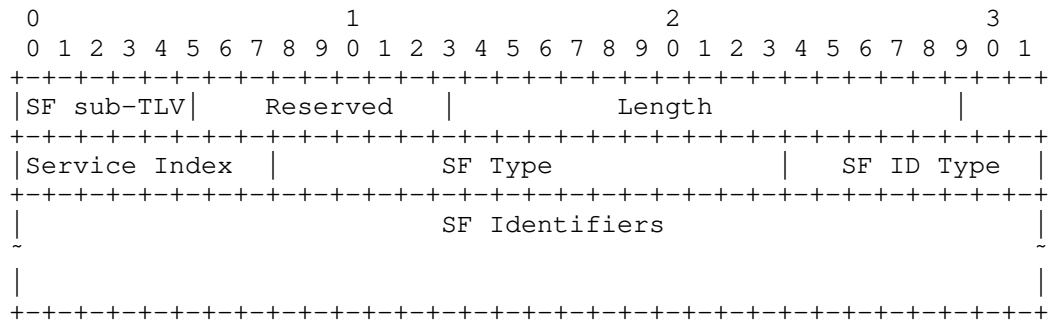


Figure 3: Service Function information sub-TLV

SF sub-TLV Type: Two octets long field. It indicates that the TLV is an SF TLV that contains the information of one SF.

Length: Two octets long field. The value of the field is the length of the data following the Length field counted in octets.

Service Index: Indicates the SF's position on the SFP.

SF Type: Two octets long field. It is defined in [I-D.ietf-bess-nsh-bgp-control-plane] and indicates the type of SF, e.g., Firewall, Deep Packet Inspection, WAN optimization controller, etc.

Reserved: For future use. MUST be zeroed on transmission and MUST be ignored on receipt.

SF ID Type: One octet-long field with values defined as Section 5.4.

SF Identifier: An identifier of the SF. The length of the SF Identifier depends on the type of the SF ID Type. For example, if the SF Identifier is its IPv4 address, the SF Identifier should be 32 bits. SF ID Type and SF Identifier may be a list, indicating the list of the SFs are which are included in a load balance group.

### 3.4. SF Information Sub-TLV Construction

Each SFF in the SFP MUST send one and only one COAM Reply corresponding to the COAM Request. If only one SF is attached to the SFF in such SFP, only one SF information sub-TLV is included in the COAM Reply. If several SFs attached to the SFF in the SFP, SF Information Sub-TLV MUST be constructed as described below in either Section 3.4.1 and Section 3.4.2.

#### 3.4.1. Multiple SFs as hops of SFP

Multiple SFs attached to the same SFF are the hops of the SFP. The service indexes of these SFs are different. Service function types of these SFs could be different or be the same. Information about all SFs MAY be included in the COAM Reply message. Information about each SF MUST be listed as separate SF Information Sub-TLVs in the COAM Reply message.

An example of the COAM procedure for this case is shown in Figure 4. The Service Function Path(SPI=x) is SF1->SF2->SF4->SF3. The SF1, SF2 and SF3 are attached to SFF1, and SF4 is attached to SFF2. The COAM Request message is sent to the SFFs in the sequence of the SFP(SFF1->SFF2->SFF1). Every SFF(SFF1, SFF2) replies with the information of SFs belonging to the SFP. The SF information Sub-TLV in Figure 3 contains information for each SF (SF1, SF2, SF3, and SF4).

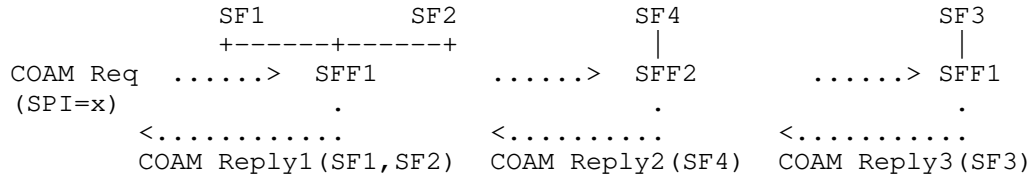


Figure 4: Example 1 for COAM Reply with multiple SFs

### 3.4.2. Multiple SFs for load balance

Multiple SFs may be attached to the same SFF to balance the load; in other words, that means that the particular traffic flow will traverse only one of these SFs. These SFs have the same Service Function Type and Service Index. For this case, the SF identifiers and SF ID Type of all these SFs will be listed in the SF Identifiers field and SF ID Type in a single SF information sub-TLV of COAM Reply message. The number of these SFs can be calculated according to SF ID Type and the value of the Length field of the sub-TLV.

An example of the COAM procedure for this case is shown in Figure 5. The Service Function Path (SPI=x) is SF1a/SF1b->SF2a/SF2b. The Service Functions SF1a and SF1b are attached to SFF1, which balances the load among them. The Service Functions SF2a and SF2b are attached to SFF2, which, in turn, balances its load between them. The COAM Request message is sent to the SFFs in the sequence of the SFP (i.e. SFF1->SFF2). Every SFF (SFF1, SFF2) replies with the information of SFs belonging to the SFP. The SF information Sub-TLV in Figure 3 contains information for all SFs at that hop.

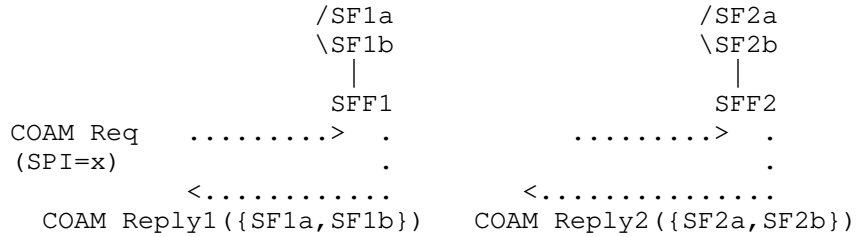


Figure 5: Example 2 for COAM Reply with multiple SFs

## 4. Security Considerations

Security considerations discussed in [RFC8300] and [I-D.ietf-sfc-multi-layer-oam] apply to this document.

Also, since Service Function sub-TLV discloses information about the SFP the spoofed COAM Request packet may be used to obtain network information, it is RECOMMENDED that implementations provide a means of checking the source addresses of COAM Request messages, specified in SFC Source TLV [I-D.ietf-sfc-multi-layer-oam], against an access list before accepting the message.

## 5. IANA Considerations

### 5.1. COAM Message Types

IANA is requested to assign values from its Message Types sub-registry in SFC Echo Request/Echo Reply Message Types registry as follows:

| Value | Description | Reference |
|---|---|---|
| TBA1 | SFP Consistency Echo Request | This document |
| TBA2 | SFP Consistency Echo Reply | This document |

Table 1: SFP Consistency Echo Request/Echo Reply Message Types

### 5.2. SFF Information Record TLV Type

IANA is requested to assign a new type value from SFC OAM TLV Type registry as follows:

| Value | Description | Reference |
|---|---|---|
| TBA3 | SFF Information Record Type | This document |

Table 2: SFF-Information Record

### 5.3. SF Information Sub-TLV Type

IANA is requested to assign a new type value from SFC OAM TLV Type registry as follows:

| Value | Description | Reference |
|---|---|---|
| TBA4 | SF Information | This document |

Table 3: SF-Information Sub-TLV Type

### 5.4. SF Identifier Types

IANA is requested to create in the registry SF Types the new sub-registry SF Identifier Types. All code points in the range 1 through 191 in this registry shall be allocated according to the "IETF Review" procedure as specified in [RFC8126] and assign values as follows:

| Value | Description | Reference |
|---|---|---|
| 0 | Reserved | This document |
| TBA6 | IPv4 | This document |
| TBA7 | IPv6 | This document |
| TBA8 | MAC | This document |
| TBA8+1-191 | Unassigned | IETF Review |
| 192-251 | Unassigned | First Come First Served |
| 252-254 | Unassigned | Private Use |
| 255 | Reserved | This document |

Table 4: SF Identifier Type

## 6. Acknowledgements

The authors are thankful to John Drake for his review and the reference to the work on BGP Control Plane for NSH SFC. The authors express their appreciation to Joel M. Halpern for his suggestion about the load balancing scenario. The authors also thank Dirk von Hugo, for his useful comments.

## 7. References

### 7.1. Normative References

[I-D.ietf-sfc-multi-layer-oam]
Mirsky, G., Meng, W., Khasnabish, B., and C. Wang, "Active OAM for Service Function Chaining", Work in Progress, Internet-Draft, draft-ietf-sfc-multi-layer-oam-09, 11 February 2021, <https://tools.ietf.org/html/draft-ietf-sfc-multi-layer-oam-09>.

[I-D.ietf-sfc-nsh-integrity]
Boucadair, M., Reddy, T., and D. Wing, "Integrity Protection for the Network Service Header (NSH) and Encryption of Sensitive Context Headers", Work in Progress, Internet-Draft, draft-ietf-sfc-nsh-integrity-05, 23 March 2021, <https://tools.ietf.org/html/draft-ietf-sfc-nsh-integrity-05>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC8126] Cotton, M., Leiba, B., and T. Narten, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 8126, DOI 10.17487/RFC8126, June 2017, <https://www.rfc-editor.org/info/rfc8126>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/info/rfc8174>.

[RFC8300] Quinn, P., Ed., Elzur, U., Ed., and C. Pignataro, Ed., "Network Service Header (NSH)", RFC 8300, DOI 10.17487/RFC8300, January 2018, <https://www.rfc-editor.org/info/rfc8300>.

## 7.2. Informational References

[I-D.ietf-bess-nsh-bgp-control-plane]
Farrel, A., Drake, J., Rosen, E., Uttaro, J., and L. Jalil, "BGP Control Plane for the Network Service Header in Service Function Chaining", Work in Progress, Internet-Draft, draft-ietf-bess-nsh-bgp-control-plane-18, 21 August 2020, <https://tools.ietf.org/html/draft-ietf-bess-nsh-bgp-control-plane-18>.

[RFC7665] Halpern, J., Ed. and C. Pignataro, Ed., "Service Function Chaining (SFC) Architecture", RFC 7665, DOI 10.17487/RFC7665, October 2015, <https://www.rfc-editor.org/info/rfc7665>.

[RFC8924] Aldrin, S., Pignataro, C., Ed., Kumar, N., Ed., Krishnan, R., and A. Ghanwani, "Service Function Chaining (SFC) Operations, Administration, and Maintenance (OAM) Framework", RFC 8924, DOI 10.17487/RFC8924, October 2020, <https://www.rfc-editor.org/info/rfc8924>.

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