

Workgroup: MPLS

Internet-Draft:

draft-decraene-mpls-slid-encoded-entropy-label-id-05

Updates: [6790](#) (if approved)

Published: 12 December 2022

Intended Status: Standards Track

Expires: 15 June 2023

Authors: B. Decraene, Ed. C. Filsfils  
Orange Cisco Systems, Inc.  
W. Henderickx T. Saad V. Beeram  
Nokia Juniper Networks Juniper Networks  
L. Jalil  
Verizon

**Using Entropy Label for Network Slice Identification in MPLS networks.**

## Abstract

This document updates [[RFC6790](#)] to extend the use of the TTL field of the Entropy Label in order to provide a flexible set of flags called the Entropy Label Control field.

This document also defines a solution to encode a slice identifier in MPLS in order to distinguish packets that belong to different slices, to allow enforcing per network slice policies (.e.g, QoS).

The slice identification is independent of the topology. It allows for QoS/DiffServ policy on a per slice basis in addition to the per packet QoS/DiffServ policy provided by the MPLS Traffic Class field.

In order to minimize the size of the MPLS stack and to ease incremental deployment the slice identifier is encoded as part of the Entropy Label.

## Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on 15 June 2023.

## Copyright Notice

Copyright (c) 2022 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Revised BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Revised BSD License.

## Table of Contents

- [1. Introduction](#)
  - [2. Requirements Language](#)
  - [3. Entropy Label Control field](#)
  - [4. Slice Identifier](#)
    - [4.1. Ingress LSR](#)
    - [4.2. Transit LSR](#)
    - [4.3. Bandwidth-Allocation Slice](#)
    - [4.4. Backward Compatibility](#)
    - [4.5. Benefits](#)
  - [5. Examples of more ELC usages](#)
    - [5.1. End to end absolute loss measurements](#)
    - [5.2. Programmed sampling of packets](#)
  - [6. Deployment Considerations](#)
  - [7. Implementation Status](#)
  - [8. Security Considerations](#)
  - [9. IANA Considerations](#)
  - [10. Changes / Authors Notes](#)
  - [11. Acknowledgements](#)
  - [12. References](#)
    - [12.1. Normative References](#)
    - [12.2. Informative References](#)
- [Authors' Addresses](#)

## 1. Introduction

This document defines a solution to encode a slice identifier in MPLS in order to provide QoS on a per slice basis. It allows for QoS/DiffServ policy on a per slice basis in addition to the per packet QoS/DiffServ policy provided by the MPLS Traffic Class field. The

slice identification is independent of the topology and the QoS of the network, thus enabling scalable network slicing.

This document encodes the slice identifier in a portion of the MPLS Entropy Label (EL) defined in [\[RFC6790\]](#) . This has advantages as it avoids the use of additional label which would increase the size of the label stack. This also reuses the data plane processing of the Entropy Label on the egress LSR, the signaling of the Entropy Label capability from the egress to the ingress [\[RFC9088\]](#) [\[RFC9089\]](#) , and the signaling capability of transit routers to read this label [\[RFC8491\]](#) which allows for an easier and faster incremental deployment.

## 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. Entropy Label Control field

[\[RFC6790\]](#) defines the MPLS Entropy Label. [\[RFC6790\]](#) section 4.2 defines the use of the Entropy Label Indicator (ELI) followed by the Entropy Label (EL) and the MPLS header fields (Label, TC, S, TTL) in each. [\[RFC6790\]](#) also specifies that the TTL field of the EL must be set to zero by the ingress LSR.

Following the procedures of [\[RFC6790\]](#) EL is never used for forwarding and its TTL is never looked at nor decremented:

- \*An EL capable Egress LSR performs a lookup on the ELI and as a result pop two labels: ELI and EL.

- \*An EL non-capable Egress LSR performs a lookup on the ELI and as a result must drop the packet as specified in [\[RFC3031\]](#) for the handling of an invalid incoming label.

Hence essentially the TTL field of the EL behaves as a reserved field which must be set to zero when sent and ignored when received.

This documents extends the TTL field of the EL and calls it the Entropy Label Control (ELC) field. The ELC is a set of eight flags: ELC0 for bit 0, ELC1 for bit 1, ..., ELC7 for bit 7.

Given that the MPLS header is very compact (32 bits) with no reserved bits and that MPLS is used within a trusted administrative domain, the semantic of these bits is not standardized but defined on a per administrative domain basis. This allows for increased re-use and

flexibility of this scarce resource. As a consequence, an application using one of those butts MUST allow the choice of the bit by configuration by the network operator.

#### 4. Slice Identifier

Each network slice in an MPLS domain is uniquely identified by a Slice Identifier (SLID) [[I-D.bestbar-teas-ns-packet](#)]. This section encodes the SLID in a portion of the MPLS Entropy Label defined in [[RFC6790](#)].

The number of bits to be used for encoding the SLID in the EL is governed by a local policy and uniform within a network slice policy domain.

##### 4.1. Ingress LSR

When an ingress LSR classifies that a packet belongs to the slice and that the egress has indicated via signaling that it can process EL for the tunnel, the ingress LSR pushes an Entropy Label with the:

- \*SLID encoded in the most significant bits of the Entropy Label.
- \*the entropy information encoded in the remaining lower bits of the Entropy Label as described in section 4.2 of [[RFC6790](#)].
- \*SPI bit (SLID Presence Indicator) set in one bit of the ELC field.

The choice of the ELC field used for SPI, and the number of bits to be used for encoding the SLID MUST be configurable by the network operator.

The slice classification method is outside the scope of this document.

The encoding of the Slide ID in the Entropy Label is in line with the specification of the Flow Label as the slide identification is a property of the flow:

- \*For a given flow it is constant in all packets.
- \*It's a property specific to the flow so would typically be used to determine the Entropy Label.

##### 4.2. Transit LSR

Any LSR that forwards a packet with the SPI bit set MUST use the SLID to select a slice and apply per-slice policies.

There are many different policies that could define a slice for a particular application or service. The most basic of these is bandwidth-allocation, an implementation complying with this specification SHOULD support the bandwidth-allocation slice as defined in the next section.

#### 4.3. Bandwidth-Allocation Slice

A per-slice policy is configured at each interface of each router in the domain, with one traffic shaper per SLID. The bit rate of each shaper is configured to reflect the bandwidth allocation of the per-slice policy.

If shapers are not available, or desirable, an implementation MAY configure one scheduling queue per SLID with a guaranteed bandwidth equal to the bandwidth-allocation for the slice. This option allows a slice to consume more bandwidth than its allocation when available.

Per-slice shapers or queues effectively provides a virtual port per slice. This solution MAY be complemented with a per-virtual-port hierarchical DiffServ policy. Within the context of one specific slice, packets are further classified into children DiffServ queues which hang from the virtual port. The Traffic Class value in the MPLS header SHOULD be used for queue selection.

#### 4.4. Backward Compatibility

The Entropy Label usage described in this document is consistent with [\[RFC6790\]](#) as ingress LSRs freely chooses the EL of a given flow, and transit LSRs treat the EL as an opaque set of bits.

As per [\[RFC6790\]](#) an ingress LSR that does not support this extension has the SPI bit cleared, and thus does not enable the SLID semantic of the Entropy bits. Hence, SLID-aware transit LSRs will not classify these packets into a slice.

#### 4.5. Benefits

From a Segment Routing architecture perspective, this network slice identifier for SR-MPLS is inline with the network slice identifier for SRv6 proposed in [\[I-D.filsfils-spring-srv6-stateless-slice-id\]](#) .

From an SR-MPLS perspective, using the EL to carry the network slice identifier has multiple benefits:

- \*This limits the number of labels pushed on the MPLS stack compared to using a pair of labels (ELI+EL) for flow entropy plus two or three labels for the slice indicator and the slice identifier. This is beneficial for the ingress LSR which may have limitations with regards to the number of labels pushed, for the transit LSR

which may have limitations with regards to the label stack depth to be examined during transit in order to read both the entropy and the SLID. This presents additional benefit to network operators by reducing the packet overhead for traffic carried through the network;

\*This avoids defining new extensions for the signaling of the egress capability to support the slice indicator and the slice identifier;

\*This improves incremental deployment as all egress LSRs supporting EL can be sent the slice identifier from day one, allowing slice classification on transit LSRs.

## **5. Examples of more ELC usages**

### **5.1. End to end absolute loss measurements**

This section describes the usage of a ELC flag to enable packet loss measurements, as described in section 3.1 of [[RFC8321](#)] .

TBD

### **5.2. Programmed sampling of packets**

This section describes the usage of a ELC flag to detect end to end packet loss.

TBD

## **6. Deployment Considerations**

The number of bits to be used for encoding the SLID in the EL affects the number of effective entropy bits. The total number of raw bits available for encoding entropy is not changed as the slice ID is part of the flow identification and contains some entropy. However this is expected to reduce the effective number of entropy bit as the slice ID is likely to less effectively encode entropy information compared to the use of a good hash function. The effective reduction of entropy depends on how good the [[RFC6790](#)] entropy value is computed (which is implementation dependent) and the statistical distribution of the usage of slice identifier. In order to minimize this reduction, network operators should set the size of the field encoding the slice identifier to the minimum size required for the number of slides used in deployment.

## 7. Implementation Status

The following hardware platforms support "end-to-end" network slicing/ partitioning as described in [Section 4](#) :

\*Cisco NCS platforms based on Broadcom Jericho2 family of ASIC. The support includes the ingress as well as the transit LSRs roles.

## 8. Security Considerations

The MPLS forwarding plane is insecure. If an adversary can affect the forwarding plane, then they can inject data, remove data, corrupt data, or modify data.

This documents additionally allows an adversary to change the slice of a packet, and to add or remove indicators/flags.

Link-level security mechanisms can help mitigate some on-link attacks, but does nothing to preclude hostile nodes.

## 9. IANA Considerations

This document has no IANA actions.

## 10. Changes / Authors Notes

[RFC Editor: Please remove this section before publication]

00: Initial version.

01: New co-author

02: Editorial precision that the slice ID is a component of flow entropy hence inline with the use of entropy label.

03: Refresh.

04: New sections: Implementation Status, Security Considerations, Deployment Considerations, Requirements Language, IANA Considerations. Editorial: replace "SR-MPLS" by "MPLS".

05: Refresh.

## 11. Acknowledgements

Authors would like to thanks Zafar Ali for his contributions.

## 12. References

### 12.1. Normative References

**[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>>.

**[RFC6790]**

Kompella, K., Drake, J., Amante, S., Henderickx, W., and L. Yong, "The Use of Entropy Labels in MPLS Forwarding", RFC 6790, DOI 10.17487/RFC6790, November 2012, <<https://www.rfc-editor.org/info/rfc6790>>.

**[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>>.

**[RFC9088]**

Xu, X., Kini, S., Psenak, P., Filsfils, C., Litkowski, S., and M. Bocci, "Signaling Entropy Label Capability and Entropy Readable Label Depth Using IS-IS", RFC 9088, DOI 10.17487/RFC9088, August 2021, <<https://www.rfc-editor.org/info/rfc9088>>.

**[RFC9089]**

Xu, X., Kini, S., Psenak, P., Filsfils, C., Litkowski, S., and M. Bocci, "Signaling Entropy Label Capability and Entropy Readable Label Depth Using OSPF", RFC 9089, DOI 10.17487/RFC9089, August 2021, <<https://www.rfc-editor.org/info/rfc9089>>.

## 12.2. Informative References

**[I-D.bestbar-teas-ns-packet]**

Saad, T., Beeram, V. P., Dong, J., Wen, B., Ceccarelli, D., Halpern, J. M., Peng, S., Chen, R., Liu, X., Contreras, L. M., Rokui, R., and L. Jalil, "Realizing Network Slices in IP/MPLS Networks", Work in Progress, Internet-Draft, draft-bestbar-teas-ns-packet-10, 5 May 2022, <<https://www.ietf.org/archive/id/draft-bestbar-teas-ns-packet-10.txt>>.

**[I-D.filsfils-spring-srv6-stateless-slice-id]**

Filsfils, C., Clad, F., Camarillo, P., Raza, S., Voyer, D., and R. Rokui, "Stateless and Scalable Network Slice Identification for SRv6", Work in Progress, Internet-Draft, draft-filsfils-spring-srv6-stateless-slice-id-06, 29 July 2022, <<https://www.ietf.org/archive/id/draft-filsfils-spring-srv6-stateless-slice-id-06.txt>>.

**[RFC3031]**

Rosen, E., Viswanathan, A., and R. Callon, "Multiprotocol Label Switching Architecture", RFC 3031, DOI 10.17487/RFC3031, January 2001, <<https://www.rfc-editor.org/info/rfc3031>>.



**[RFC8321]**

Fioccola, G., Ed., Capello, A., Cociglio, M., Castaldelli, L., Chen, M., Zheng, L., Mirsky, G., and T. Mizrahi, "Alternate-Marking Method for Passive and Hybrid Performance Monitoring", RFC 8321, DOI 10.17487/RFC8321, January 2018, <<https://www.rfc-editor.org/info/rfc8321>>.

**[RFC8491]**

Tantsura, J., Chunduri, U., Aldrin, S., and L. Ginsberg, "Signaling Maximum SID Depth (MSD) Using IS-IS", RFC 8491, DOI 10.17487/RFC8491, November 2018, <<https://www.rfc-editor.org/info/rfc8491>>.

**Authors' Addresses**

Bruno Decraene (editor)  
Orange

Email: [bruno.decraene@orange.com](mailto:bruno.decraene@orange.com)

Clarence Filsfils  
Cisco Systems, Inc.  
Belgium

Email: [cf@cisco.com](mailto:cf@cisco.com)

Wim Henderickx  
Nokia  
Copernicuslaan 50  
95134 Antwerp 2018  
Belgium

Email: [wim.henderickx@nokia.com](mailto:wim.henderickx@nokia.com)

Tarek Saad  
Juniper Networks

Email: [tsaad@juniper.net](mailto:tsaad@juniper.net)

Vishnu Pavan Beeram  
Juniper Networks

Email: [vbeeram@juniper.net](mailto:vbeeram@juniper.net)

Luay Jalil  
Verizon

Email: [luay.jalil@verizon.com](mailto:luay.jalil@verizon.com)