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 Usecases for MPLS Indicators and Ancillary Data

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Abstract

 This document presents a number of use cases that have a common need

 for encoding MPLS function indicators and ancillary data inside MPLS

 packets. The use cases described are not an exhaustive set, but

 rather the ones that are actively discussed at the MPLS Working

 Group.

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1. Introduction

 This document describes important cases that require carrying

 additional ancillary data within the MPLS packets, as well as the

 means to indicate ancillary data is present.

 These use cases have been identified by the MPLS working group design

 team working on defining MPLS function indicators and ancillary data

 for the MPLS data plane. The use cases described in this document

 will be used to assist in identifying requirements and issues to be

 considered for future resolution by the working group.

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 \* ID: draft-gandhi-mpls-ioam describes the applicability of IOAM to MPLS

 data plane.

 \* RFC 8986 describes the network programming use case for SRv6

 data plane.

 \* RFC 8595 describes a solution for MPLS-based forwarding for Service

 Function Chaining

1.1. Terminology

 The following terminology is used in the document:

 IETF Network Slice:

 a well-defined composite of a set of endpoints, the connectivity

 requirements between subsets of these endpoints, and associated

 requirements; the term 'network slice' in this document refers to

 'IETF network slice' as defined in

 [I-D.ietf-teas-ietf-network-slices].

 IETF Network Slice Controller (NSC):

 a controller that is used to realize an IETF network slice

 [I-D.ietf-teas-ietf-network-slices].

 Network Resource Partition:

 the collection of resources that are used to support a slice

 aggregate.

 Time-Sensitive Networking:

 Networks that transport time-sensitive traffic.

 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.

1.2. Acronyms and Abbreviations

 MIAD: MPLS Label Stack Indicators for Ancillary Data

 ISD: In-stack data

 PSD: Post-stack data

 MPLS: Multiprotocol Label Switching

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2. Use Cases

2.1. In-situ OAM

 In-situ Operations, Administration, and Maintenance (IOAM) may record

 operational and telemetry information within the packet while the

 packet traverses a particular path in a network domain.

 The term "in-situ" refers to the fact that the IOAM data fields are

 added to the data packets rather than being sent within the probe

 packets specifically dedicated to OAM or Performance Measurement

 (PM).

 IOAM can run in two modes End-to-End (E2E) and Hop-by-Hop (HbH). In

 E2E mode, only the encapsulating and decapsulating nodes will process

 IOAM data fields. In HbH mode, the encapsulating and decapsulating

 nodes as well as intermediate IOAM-capable nodes process IOAM data fields.

 The IOAM data fields are defined in [I-D.ietf-ippm-ioam-data], and

 can be used for various use-cases of OAM and PM.

 [I-D.gandhi-mpls-ioam-sr] defines how IOAM data fields are

 transported using the MPLS data plane encapsulations, including

 Segment Routing (SR) with MPLS data plane (SR-MPLS).

 IOAM data may be added after the bottom of the label stack. The IOAM

 data fields can be of a fixed or incremental size as defined in

 [I-D.ietf-ippm-ioam-data]. [I-D.gandhi-mpls-ioam] describes

 the applicability of IOAM to the MPLS data plane. The encapsulating MPLS node

 needs to know if the decapsulating MPLS node can process the IOAM

 data before adding it into the packet.

2.2. Network Slicing

 [I-D.ietf-teas-ietf-network-slices] specifies the definition of an

 IETF Network Slice . It further discusses the general

 framework for requesting and operating IETF Network Slices, their

 characteristics, and the necessary system components and interfaces.

 Multiple network slices can be realized on top of a single shared

 network.

 In order to overcome scale challenges, IETF Network Slices may be

 aggregated into groups according to similar characteristics. The

 slice aggregate [I-D.bestbar-teas-ns-packet] is a construct that

 comprises of the traffic flows of one or more IETF Network Slices of

 similar characteristics.

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 A router that requires forwarding of a packet that belongs to a slice

 aggregate may have to decide on the forwarding action to take based

 on selected next-hop(s), and the forwarding treatment (e.g.,

 scheduling and drop policy) to be enforced based on the associated per-

 hop behavior.

 The routers in the network that forward traffic over links that are

 shared by multiple slice aggregates need to identify the slice

 aggregate packets in order to enforce the associated forwarding

 action and treatment.

 An IETF network slice MAY support the following key features:

 1. A Slice Selector

 2. A Network Resource Partition associated with a slice aggregate.

 3. A Path selection criteria

 4. Verification that per slice SLOs are being met. This may be done

 by active measurements (inferred) or by using hybrid measurement methods, e.g., IOAM.

 5. Additionally, there is an ongoing discussion on using Service

 Functions (SFs) with network slices. This may require insertion

 of an NSH.

 6. For multi-domain scenarios, a packet that traverses multiple

 domains may encode different identifiers within each domain.

2.2.1. Global Identifier as Slice Selector

 A Global Identifier as a Slice Selector (GISS) can be encoded in the

 MPLS packet as defined in [I-D.kompella-mpls-mspl4fa],

 [I-D.li-mpls-enhanced-vpn-vtn-id], and

 [I-D.decraene-mpls-slid-encoded-entropy-label-id]. The Global

 Identifier Slice Selector can be used to associate the packets to the

 slice aggregate, independent of the MPLS forwarding label that is

 bound to the destination. LSRs use the MPLS forwarding label to

 determine the forwarding next-hop(s), and use the Global Identifier

 Slice Selector field in the packet to infer the specific forwarding

 treatment that needs to be applied on the packet.

 The GISS can be encoded within an MPLS label stack element that is carried in the

 packet's MPLS label stack. All packets that belong to the same slice

 aggregate MAY carry the same GISS in the MPLS label stack. It is

 also possible to have multiple GISS's map to the same slice

 aggregate. The GISS can be encoded in an MPLS label and may appear

 in several positions in the MPLS label stack.

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2.2.2. Forwarding Label as a Slice Selector

 [RFC3031] states in Section 2.1 that: 'Some routers analyze a

 packet's network layer header not merely to choose the packet's next

 hop, but also to determine a packet's "precedence" or "class of

 service"'.

 It is possible by assigning a unique MPLS forwarding label to each

 slice aggregate (FEC) to distinguish the packets forwarded to the

 same destination that belong to different slice aggregates. In

 this case, LSRs can use the top forwarding label to infer both the

 forwarding action and the forwarding treatment to be invoked on the

 packets. A similar approach is described in

 [I-D.ietf-spring-resource-aware-segments] and

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

2.3. Time-Sensitive Networking

 The routers in a network can perform two distinct functions on

 incoming packets, namely forwarding (where the packet should be sent)

 and scheduling (when the packet should be sent). Time Sensitive

 Networking (TSN) and Deterministic Networking provide several

 mechanisms for scheduling under the assumption that routers are time-

 synchronized. The most effective mechanisms for delay minimization

 involve per-flow resource allocation.

 Segment Routing (SR) is a forwarding paradigm that allows encoding

 forwarding instructions in the packet in a stack data structure,

 rather than being programmed into the routers. The SR instructions

 are contained within a packet in the form of a First-in, First-out

 stack dictating the forwarding decisions of successive routers.

 Segment routing may be used to choose a path sufficiently short to be

 capable of providing sufficiently low end-to-end latency but does

 not influence the queueing of individual packets in each router along

 that pat

 TSN is required for networks transporting time-sensitive traffic,

 that is, packets that are required to be delivered to their final

 destination by a given time.

2.3.1. Stack-based Methods for Latency Control

 One efficient data structure for inserting local deadlines into the

 headers is a "stack", similar to that used in Segment Routing to

 carry forwarding instructions. The number of deadline values in the

 stack equals the number of routers the packet needs to traverse in

 the network, and each deadline value corresponds to a specific

 router. The Top-of-Stack (ToS) corresponds to the first router's

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 deadline while the Bottom-of-Stack (BoS) refers to the last's. All

 local deadlines in the stack are later or equal to the current time

 (upon which all routers agree), and times closer to the ToS are

 always earlier or equal to times closer to the BoS.

 The ingress router inserts the deadline stack into the packet

 headers; no other router needs to be aware of the requirements of the

 time-sensitive flows. Hence admitting a new flow only requires

 updating the information base of the ingress router.

 MPLS LSRs that expose the Top of Stack (ToS) label can also inspect

 the associated "deadline" carried in the packet (either in MPLS stack

 or after BoS).

2.3.2. Stack Entry Format

 A number of different time formats commonly used in networking

 applications and can be used to encode the local deadlines.

 For the forwarding sub-entry, we could adopt like SR-MPLS standard

 32-bit MPLS labels (which contain a 20-bit label and BoS bit), and

 thus SR-TSN stack entries could be 64-bits in size, comprising a

 32-bit MPLS label and the aforementioned non-standard 32-bit

 timestamp.

 Alternatively, an SR-TSN stack entry could be 96 bits in length

 comprising a 32-bit MPLS label and either of the standardized 64-bit

 timestamps.

2.4. NSH Based Service Function Chaining

 The Network Service Header (NSH) can be embedded in an Extended

 Header (EH) to support the Path ID and any metadata that needs to be

 carried and exchanged between Service Function Forwarders (SFFs).

 A reference to the NSH SFC use case is defined in [RFC8596].

2.5. Network Programming

 In SR, an ingress node steers a packet through an ordered list of

 instructions, called "segments". Each one of these instructions

 represents a function to be called at a specific location in the

 network. A function is locally defined on the node where it is

 executed and may range from simply moving forward in the segment list

 to any complex user-defined behavior.

 Network Programming combines Segment Routing (SR) functions to

 achieve a networking objective that goes beyond mere packet routing.

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 It may be desirable to encode a pointer to function and its

 arguments within an MPLS packet transport header. For

 example, in MPLS, we can encode the FUNC::ARGs within the label stack

 or after the Bottom of Stack to support the equivalent of FUNC::ARG

 in SRv6 as described in [RFC8986].

2.6. Application-Aware Networking (APN)

 Application-aware Networking (APN) allows application-aware

 information (i.e., APN attribute) including APN identification (ID)

 and/or APN parameters (e.g., network performance requirements) to be

 encapsulated at network edge devices and carried in packets

 traversing an APN domain in order to facilitate service provisioning,

 perform fine-granularity traffic steering and network resource

 adjustment. To support APN in MPLS networks, mechanisms are needed

 to hold the APN attribute.

3. Co-existence of Usecases

 Two or more of the aforementioned use cases MAY co-exist in the same

 packet. Some examples of such usecases are described below.

3.1. IOAM with Network Slicing

 IOAM may provide key functions with network slicing to help ensure

 that critical network slice SLOs are being met by the network

 provider.

 In such a case, IOAM is able to collect key performance measurement

 parameters of network slice traffic flow as it traverses the

 transport network.

 This may require, in addition to carrying a specific network slice

 selector (e.g., GISS), the MPLS network slice packets may have to

 also carry IOAM ancillary data.

 Note that the IOAM ancillary data may have to be modified, and

 updated on some/all LSRs traversed by the network slice MPLS packets.

3.2. IOAM with Time-Sensitive Networking

 IOAM operation may also be desirable on MPLS packets that carry time-

 sensitive related data. Similarly, this may require the presence of

 multiple ancillary data (whether In-stack or Post-stack ancillary

 data) to be present in the same MPLS packet.

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4. IANA Considerations

 This document has no IANA actions.

5. Security Considerations

 This document introduces no new security considerations.

6. Acknowledgement

 The authors gratefully acknowledge the input of the members of the

 MPLS Open Design Team.

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8. References

8.1. 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>.

 [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>.

8.2. Informative References

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

 Saad, T., Beeram, V. P., Wen, B., Ceccarelli, D., Halpern,

 J., Peng, S., Chen, R., Liu, X., Contreras, L. M., Rokui,

 R., and L. Jalil, "Realizing Network Slices in IP/MPLS

Saad, et al. Expires 11 July 2022 [Page 9]

Internet-Draft MIAD Usecases January 2022

 Networks", Work in Progress, Internet-Draft, draft-

 bestbar-teas-ns-packet-06, 22 December 2021,

 <https://www.ietf.org/archive/id/draft-bestbar-teas-ns-

 packet-06.txt>.

 [I-D.decraene-mpls-slid-encoded-entropy-label-id]

 Decraene, B., Filsfils, C., Henderickx, W., Saad, T.,

 Beeram, V. P., and L. Jalil, "Using Entropy Label for

 Network Slice Identification in MPLS networks.", Work in

 Progress, Internet-Draft, draft-decraene-mpls-slid-

 encoded-entropy-label-id-02, 6 August 2021,

 <https://www.ietf.org/archive/id/draft-decraene-mpls-slid-

 encoded-entropy-label-id-02.txt>.

 [I-D.gandhi-mpls-ioam]

 Gandhi, R., Ali, Z., Brockners, F., Wen, B., Decraene, B.,

 and V. Kozak, "MPLS Data Plane Encapsulation for In-situ

 OAM Data", Work in Progress, Internet-Draft, draft-gandhi-

 mpls-ioam-01, 9 September 2021,

 <https://www.ietf.org/archive/id/draft-gandhi-mpls-ioam-

 01.txt>.

 [I-D.gandhi-mpls-ioam-sr]

 Gandhi, R., Ali, Z., Filsfils, C., Brockners, F., Wen, B.,

 and V. Kozak, "MPLS Data Plane Encapsulation for In-situ

 OAM Data", Work in Progress, Internet-Draft, draft-gandhi-

 mpls-ioam-sr-06, 18 February 2021,

 <https://www.ietf.org/archive/id/draft-gandhi-mpls-ioam-

 sr-06.txt>.

 [I-D.ietf-ippm-ioam-data]

 Brockners, F., Bhandari, S., and T. Mizrahi, "Data Fields

 for In-situ OAM", Work in Progress, Internet-Draft, draft-

 ietf-ippm-ioam-data-17, 13 December 2021,

 <https://www.ietf.org/archive/id/draft-ietf-ippm-ioam-

 data-17.txt>.

 [I-D.ietf-spring-resource-aware-segments]

 Dong, J., Bryant, S., Miyasaka, T., Zhu, Y., Qin, F., Li,

 Z., and F. Clad, "Introducing Resource Awareness to SR

 Segments", Work in Progress, Internet-Draft, draft-ietf-

 spring-resource-aware-segments-03, 12 July 2021,

 <https://www.ietf.org/archive/id/draft-ietf-spring-

 resource-aware-segments-03.txt>.

 [I-D.ietf-teas-ietf-network-slices]

 Farrel, A., Gray, E., Drake, J., Rokui, R., Homma, S.,

 Makhijani, K., Contreras, L. M., and J. Tantsura,

Saad, et al. Expires 11 July 2022 [Page 10]

Internet-Draft MIAD Usecases January 2022

 "Framework for IETF Network Slices", Work in Progress,

 Internet-Draft, draft-ietf-teas-ietf-network-slices-05, 25

 October 2021, <https://www.ietf.org/archive/id/draft-ietf-

 teas-ietf-network-slices-05.txt>.

 [I-D.kompella-mpls-mspl4fa]

 Kompella, K., Beeram, V. P., Saad, T., and I. Meilik,

 "Multi-purpose Special Purpose Label for Forwarding

 Actions", Work in Progress, Internet-Draft, draft-

 kompella-mpls-mspl4fa-01, 12 July 2021,

 <https://www.ietf.org/archive/id/draft-kompella-mpls-

 mspl4fa-01.txt>.

 [I-D.li-mpls-enhanced-vpn-vtn-id]

 Li, Z. and J. Dong, "Carrying Virtual Transport Network

 Identifier in MPLS Packet", Work in Progress, Internet-

 Draft, draft-li-mpls-enhanced-vpn-vtn-id-01, 14 April

 2021, <https://www.ietf.org/archive/id/draft-li-mpls-

 enhanced-vpn-vtn-id-01.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>.

 [RFC8596] Malis, A., Bryant, S., Halpern, J., and W. Henderickx,

 "MPLS Transport Encapsulation for the Service Function

 Chaining (SFC) Network Service Header (NSH)", RFC 8596,

 DOI 10.17487/RFC8596, June 2019,

 <https://www.rfc-editor.org/info/rfc8596>.

 [RFC8986] Filsfils, C., Ed., Camarillo, P., Ed., Leddy, J., Voyer,

 D., Matsushima, S., and Z. Li, "Segment Routing over IPv6

 (SRv6) Network Programming", RFC 8986,

 DOI 10.17487/RFC8986, February 2021,

 <https://www.rfc-editor.org/info/rfc8986>.

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