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Requirements for MPLS Network Action Indicators and MPLS Ancillary Data

draft-ietf-mpls-miad-mna-requirements-00

Abstract

This draft specifies requirements for indicators in the MPLS label stack to support ancillary data in the packet and high level requirements on that ancillary data. This work is the product of the IETF MPLS Open Design Team. Requirements are derived from a number of new proposals for additions to the MPLS label stack to allow forwarding or other processing decisions to be made, either by a transit or terminating LSR (i.e. the LER), based on application data that may be in or below the bottom of the label stack.

Status of This Memo

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

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1. Introduction

There is significant interest in developing the MPLS data plane to address the requirements of new applications [I-D.saad-mpls-miad-usecases]. These applications typically require the inclusion of ancillary data in the MPLS packet. This data may be encoded either in the label stack or below the bottom of the label stack. This data is then either intercepted and processed, or some other forwarding decision is taken by routers processing the packet. The ancillary data is added by the ingress LSR, and is then processed using mechanisms implemented by intermediate and/or egress LSRs that comply with the MPLS base architecture and potentially its extensions, including (but not limited to) [RFC3031], [RFC3032], [RFC6790].

This draft specifies requirements for indicators in the MPLS label stack to support these applications, as well as the encoding and use of the ancillary data.

1.1. Terminology

- Ancillary Data (AD): Data relating to the MPLS packet that may be used to affect the forwarding or other processing of that packet, either at an Label Edge Router (LER) [RFC4221] or Label Switching

Router (LSR). This data may be encoded within a network action sub-stack (see below) (in-stack data), and/or after the bottom of the label stack (post-stack data).

- Network Action: An operation to be performed on a packet. A network action may affect router state, packet forwarding, or it may affect the packet in some other way.
  A network action is said to be present if there is an indicator in the packet that invokes the action.

- Network Action Indication (NAI): An indication in the packet that a certain network action is to be perfomed. There may be associated ancillary data in the packet.

- Network Action Sub-Stack (NAS): A set of related, contiguous Label Stack Entries (LSEs).
  The first LSE contains the NAI. The TC and TTL values in the sub-stack may be redefined.
  The label field in the second and following LSE may be redefined.
  Solutions MUST NOT redefine the S bit. See Section 3.1 through Section 3.5.

- In-Stack Data: Any data within the MPLS label stack including the outer LSE and the bottom of stack (the LSE with the S-bit set).

- Post-Stack Data: Any data beyond the LSE with the S-Bit set, but before the first octet of the user payload. This document does not prescribe whether post-stack data precedes or follows any other protocol structure such as a control word or associated channel header (ACH).

- Scope: The set of nodes that should perform a given action.

1.2. Background

The MPLS architecture is specified in [RFC3031] and provides a mechanism for forwarding packets through a network without requiring any analysis of the packet payload's network layer header by intermediate nodes (Label Switching Routers - LSRs). Formally, inspection may only occur at network ingress (the Label edge router - LER) where the packet is assigned to a forwarding equivalence class (FEC).

MPLS uses switching based on a label pushed on the packet to achieve efficient forwarding and traffic engineering of flows associated with the FEC. While originally used for IP traffic, MPLS has been extended to support point-to-point, point-to-multipoint and multipoint-to-multipoint layer 2 and layer 3 services. An overview

of the development of MPLS is provided in [I-D.bryant-mpls-dev-primer].

A number of applications have emerged which require LSRs to make forwarding or other processing decisions based on inspection of the network layer header, or some other ancillary information in the protocol stack encapsulated deeper in the packet. An early example of this was generation of a hash of the payload header to be used for load balancing over Equal Cost Multipath (ECMP) or Link Aggregation Group (LAG) next hops. This is based on an assumption that the network layer protocol is IP. MPLS was extended to avoid the need for LSRs to perform this operation if load balancing was needed based on the payload and instead use only the MPLS label stack, using the Entropy Label / Entropy Label Indicator [RFC6790] which are inserted at the LER. Other applications where the intermediate LSRs may need to inspect and process a packet on an LSP include OAM, which can make use of mechanisms such the Router Alert Label [RFC3032] or the Generic Associated Channel Label (GAL) [RFC5586] to indicate that an intercepted packet should be processed locally. See [I-D.bryant-mpls-dev-primer] for detailed list of such applications.

There have been a number of new proposals for how ancillary data is carried in MPLS and how its presence is indicated to the LSR or egress LER, for example In-situ OAM and Service Function Chaining (SFC). A summary of these proposals is contained in [I-D.bryant-mpls-dev-primer], an overview of use cases is provided in [I-D.saad-mpls-miad-usecases]. [I-D.song-mpls-extension-header] summarises some of the issues with existing solutions to address these new applications (note that this document draws on the requirements and issues without endorsing a specific solution from [I-D.song-mpls-extension-header]):

These solutions rely on either the built-in next-protocol indicator in the header or the knowledge of the format and size of the header to access the following packet data. The node is required to be able to parse the new header, which is unrealistic in an incremental deployment environment.

A piecemeal solution often assumes the new header is the only extra header and its location in the packet is fixed by default. It is impossible or difficult to support multiple new headers in one packet due to the conflicted assumption. An example of this is that the GAL/G-ACH mechanism assumes that if the GAL is present, only a single G-ACH header follows.

New applications therefore require the definition of extensions to the MPLS architecture and label stack operations that can be used

across these applications in order to minimise implementation complexity and promote interoperability and extensibility.

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. MPLS Network Action Indicator Requirements

This document specifies requirements of MPLS Network Action Indicators, and the associated Ancillary Data. The requirements are for the behavior of the protocol mechanisms and procedures that constitute building blocks out of which indicators for network actions and associated ancillary data are constructed.
It does not specify the detailed actions and processing that may be required by an application for any ancillary data by an LSR or LER. The requirements in this document do not describe what functions an implementation must support. The purpose of this document is to identify the toolkit and any new protocol work that is required. This new protocol work MUST be based on the existing MPLS architecture.

3.1. General Requirements

1. MPLS combines extensibility, flexibility and efficiency by using control plane context combined with a simple data plane mechanism to allow the network to make forwarding decisions about a packet. Any solution MUST maintain these properties of MPLS.

2. Any solutions to these requirements MUST NOT restrict the generality of MPLS architecture [RFC3031], [RFC3032].

3. If extensions to the MPLS data plane are required, they MUST NOT be inconsistent with the MPLS architecture [RFC3031], [RFC3032].

4. Solutions meeting the requirements set out in this document MUST be able to coexist with and MUST NOT obsolete existing MPLS mechanisms.

5. The design of any mechanism SHOULD be such that an LSR is able to efficiently parse the label stack.

6. Mechanisms MUST NOT increase the size of the MPLS label stack more than is necessary.

7. The design of solutions MUST NOT expose confidential information [RFC6973] [RFC3552] to the LSRs.

8. Solution specifications MUST document any changes to the existing MPLS data plane security model that they introduce.

3.2. Requirements on Network Action Indicators

1. When an MPLS Network Action is required, and indicator is REQUIRED in the label stack.

2. An MPLS Network Action MUST specify whether ancillary data is required in the label stack and/or post-stack data.

3. Any solution MUST respect the principle that Special Purpose Labels are the mechanism of last resort and therefore must minimise the number of new SPLs that are allocated.

4. Insertion, parsing, processing and disposition of Network Action Indicators SHOULD make use of existing MPLS data plane operations.

5. An NAI MUST NOT be delivered to a node that is not capable of processing in the way in a way that is acceptable to the imposing LER.

6. NAI MUST NOT become top of stack at a node that does not understand how to perform a disposition operation on it. Disposition includes both processing and ignoring.

7. The NAI design MUST support scoping of network actions.

8. A given NAI specification MUST specify if the scope is end-to-end, hop-by-hop, or directed at one or more selected nodes.

9. If a design allows more than one scope, a mechanism MUST be provided to specify the precedence of the scopes.

10. A mechanism is REQUIRED to enable an LER inserting NAIs to determine if the far-end LER can accept and process a packet containing a given NAI.

11. NAIs SHOULD be supported for both P2P and P2MP paths, but any specific NAI may only be supported for one or the other.

12. Data plane mechanisms for NAIs MUST be consistent across different control plane protocol types.

13. A mechanism MUST be defined for control / management planes in use to determine the ability of downstream LSRs/LERs to accept/ process a given NAI.

14. A mechanism is REQUIRED to enable an LSR to determine if an NAI is present in a packet.

15. NAIs can only be inserted at LERs, but MAY be processed at LSRs and LERs. If it is required to insert an NAI at a transit LSR on an LSP, then a new label stack MUST be pushed.

16. It SHOULD be possible to include indicators for multiple network actions in the same packet.

17. The solution MUST allow NAI-carrying and non-NAI-carrying packets to coexist on the same LSP.

18. The solution MUST support the processing of a subset of the NAIs on a packet.

19. Any specification of a solution that inserts or modifies the NAI MUST discuss the possible ECMP consequences.

3.3. Requirements on Ancillary Data

1. Solutions for in-stack ancillary data MUST be able to coexist with and MUST NOT obsolete existing MPLS mechanisms.

2. A common preamble for ancillary data MUST be defined so that a node receiving the ancillary data can determine whether to process, ignore, skip over or discard it according to network or local policies.

3. Any specification of a mechanism MUST describe whether it can coexist with existing post-stack data mechanisms e.g. control words and G-ACH, and if so how this coexistence operates.

4. A mechanism MUST be defined for an LER inserting ancillary data to determine that each node that needs to process the ancillary data can read the required distance into the packet at that node, for example [RFC9088].

5. Ancillary data MAY be associated with control or maintenance information for traffic carried by an LSP, and/or it MAY be associated with the user traffic itself.

6. For scoped ancillary data, a mechanism is REQUIRED to enable an LER inserting NAIs whose network actions make use of that

ancillary data, to determine if the NAI and ancillary data will be processed by LSRs within the scope along the path. Such a mechanism MAY need to determine if LSRs along the path can process a specific type of AD implied by the NAI at the depth in the stack that it will be presented to the LSR.

7. Network action specifications MUST specify if the ancillary data needs to be processed as a part of the immediate forwarding operation and whether packet mis-ordering is allowed to occur as a result of the time taken to process the ancillary data.

8. In order to prevent unnecessary scanning of the packet, care needs to be taken in the location of post stack ancillary data, for example it SHOULD be located as close to the bottom of the label stack as possible.

9. A solution MUST be provided to verify the authenticity of ancillary data processed to LSRs [RFC3552].

10. The design of the ancillary data MUST NOT expose confidential information [RFC6973] [RFC3552] to the LSRs.

4. IANA Considerations

This document makes no request of IANA.

Note to RFC Editor: this section may be removed on publication as an RFC.

5. Security Considerations

The mechanisms required by this document introduce new security considerations to MPLS. Individual solution specifications meeting these requirements MUST address any security considerations.

6. Acknowledgements

The authors gratefully acknowledge the contributions from Greg Mirsky, Yingzhen Qu, Haoyu Song, Tarek Saad, Loa Andersson, Tony Li, John Drake and Bruno Decraene.

The authors also gratefully acknowledge the input of the members of the MPLS Open Design Team.

7. References

7.1. Normative References

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Appendix A. Working Group Adoption Comments

1. Normative Language

   Use of the normative language, Terminology section in particular. For example, in "There may be associated ancillary data in the packet."

2. The NAS abbreviation

   Network Action Sub-Stack is abbreviated as NAS. I think that abbreviating as NASS or presenting the extended term as Network Action Sub-stack improves correlation between the full form and acronym.

3. non-use of NAS abbreviation

   Also, I've noticed that NAS is not used throughout the document. It might not be useful after all.

4. Section 3.2 typo

Perhaps a typo in the first requirement Section 3.2 s/and/an/ It is not clear what "NAI is delivered to a node" might mean in the requirement 5 of Section 3.2. Perhaps the next requirement is sufficient and #5 can be removed from the document.

5. Extra words

Also, #5 seems like it has some extra wording. Perhaps s/in the way in a way/in a way/?

6. Merging of drafts?

One thing I'm debating is whether draft-bryant-mpls-dev-primer-01 - A Primer on the Development of MPLS (ietf.org) should be merged with this draft?

7. ADI -> NAI

In this version the term "Ancillary Data Indicator" is changed to "Network Action Indicator". While there is some difference between the definition of the two terms: Ancillary Data Indicator (ADI): A indicator in the MPLS label stack that ancillary data exists in this packet. It MAY also indicate the specific type of the ancillary data. Network Action Indication (NAI): An indication in the packet that a certain network action is to be performed. There may be associated ancillary data in the packet. The above definition shows that ADI firstly is the indicator of the existence of the ancillary data, and optionally can be the indicator of specific type of ancillary data. While NAI is only the indicator of a certain type of network action. Thus NAI cannot replace ADI directly in this document. I'd suggest to add the ADI back to the terminology section, and change all the NAI in section 3.2 back to ADI. If needed, the requirements on NAI can be added as separate items.

8. Addition to section 3.1

For backward compatibility and consistency, It is suggested to add the below items to section 3.1 as general requirements: a) Solutions meeting the requirements set out in this document MUST be compatible with existing MPLS mechanisms. b) Solutions meeting the requirements set out in this document MUST reuse existing MPLS mechanisms when possible. c) For network actions which are developed or under development in IETF, the encoding and processing of the network action data MUST be reused.

9. Action Indicators without AD

Do not use the ADI for Network Actions that does not have ancillary data, use NADI (non-ADI).

10. AD definition

I was under the impression reading Jie's note that actions _itself_ are the Ancillary Data. Your definition of "Ancillary Data" seems to be limited to action parameters or metadata which is likely why you draw such conclusions.

11. Optional AD?

AD definition treats anything new to the current label stack as an optional add-on == ancillary while NAI treats only optional parameters or metadata associated with newly defined actions as ancillary.

12. ADI and NAI are different

It is also my understanding that the definition of ADI and NAI are different. ADI is used to indicate that there is information in addition to the legacy label stack in the packet, while NAI is used to indicate a certain type of network action. The existence of NAI and the optional data associated with the action need an indicator, which is the ADI.

13. Retire ADI

There is no need for an ancillary data indicator and we should probably retire the term.

14. AD generic?

As Robert and I mentioned, the term ancillary data is generic and refers to all types network actions information, including those with and without additional action data.
Thus NAI can be considered as one type of ancillary data.

15. What ADI indicates

An ADI is the indicator of the presence of ANY non-label information in the MPLS packet. Following it there may be indicators of each specific network action. And my understanding is the requirements in section 3.2 was mainly on the ADI.

16. Common requirement to carry AD

According to the use cases collected, their common requirement is to carry ancillary data in the data packet to affect the packet forwarding or processing behavior, or the network states. There is no specific requirement on where the ancillary data should be put in the packet. Thus in the requirement document it would be clear enough to just mention ancillary data and its indicator (ADI).

17. Not discussed

We have not discussed changing ADI to NAI.

18. Discussed when draft presented in the Open DT

The change of ADI to NAI was presented when the new version of the Framework were discussed in the Open DT.

19. Comment from Loa

I think both comment 17 and 18, could be misunderstod, yes the NAI was introduced (for good reason) in new Framework, however it does not in itself exclude have an ADI in a packet, only that is not the all-emcompassing term that it was earlier.

20. Keep using ADI

My suggestions would be to keep using ADI for the generic indicator, and could use NAI for the indicator of specific action. I don'think we need to mention NAS here, which is specific to ISD based solution.

21. Use of NSI

I propose Network Action Sub-stack Indcator (NSI) for this purpose.
Proposed definition: An LSE used to indicate the presence of a Network Action Sub-stack.

22. Revise definition of NAS

We should also revise the definition of NAS to use this (21).

23. Popping NAS

When you pop a stack in programming, the concept that MPLS borrowed, you pop the procedure indicator and the procedure parameters. This is consistent with popping an NAS

24. More than a name change

No it is more than just a name change. There is a concept change and we re-wrote a bunch of text to align with the NAI approach. For example an NAI may not have AD to indicate.

25. Writeable NAS

I have some further questions. NAS is something within the label stack but writable by intermediate nodes. Is this the stack operation? Besides, if NAS emerges at ToS, you said it'll be popped and discarded. What if the NAS also needs to be applied to the labels below it? Whatever measures you will take here, are those the stack operations?

26. The NFRR use case

I have several questions about the NFRR use case. As I understand it, a point of local repair (PLR) imposes NAS with the NFRR indicator so that it becomes ToS at the merge node (MN). If that is correct, then the MN will remove the NAS with the NFRR indicator as the packet is returned on the "normal" path. Hence, I don't see why an intermediate node would need to write into an existing in the label stack NAS in support of NFRR.

27. Intermediate node re-writing

I may not see a case for an intermediate node re-writing the existing NAI. I think that the node should impose a new NAS. I see the case for an intermediate node writing into PSD (e.g., HbH IOAM though I think that is too expensive and the IOAM Direct Export or Hybrid Two-Step are a better choice). To summarize, I don't see the need for an intermediate node to write into ISD and am open to discussing the node writing into PSD.

28. Two types of indicators

One of my concern is that there are two types of indicators, and they cannot be represented using the same term. - The first one (call it indicator-1) is used to indicate the presence of any non-forwarding-label information in the packet. As discussed it may be realized as a bSPL. It does not indicate the type of actions to be performed. - The second type of indicator (call it indicator-2) is used to indicate the presence of a specific type of action. Such action may or may not have associated data

with it. This may be realized as a Flag or an action type in the packet.

29. Second term needed

do not understand why we need another term. We have not had a situation where we wanted to refer to "NAS + PSD" and lacked a term for it.

30. Propose text

That said, please feel free to propose a term and a definition. I do not understand why we need another term. We have not had a situation where we wanted to refer to "NAS + PSD" and lacked a term for it.

That said, please feel free to propose a term and a definition.

31. NAS not general enough

Thus NAS is not general enough to cover the PSD. What we need is a generic term to cover all the possible cases of ancillary data. Furthermore, the indicator and the ancillary data would need separate terms anyway and does not need to be coupled under one term.

32. Use of ancillary data

* We are already using ancillary data for this purpose

* Exactly, and that' why we don't need to mention NAS in the requirement document.

33. What the NAS contain

* Let me put it this way: By definition, NAS contains: ADI, Optional NAI and Optional ISD. While what we want to refer to with the term is: Optional NAI Optional ISD and Optional PSD. Note it does not include the ADI.

* This is incorrect. It contains a network action sub-stack indicator, network action indicators, and any in-stack ancillary data (as defined by the specified network actions)

34. User-defined actions

user-defined network actions? Should we mentione in the requirements doc?

35. draft-ietf-mpls-mna-requirements

I hope, if adopted, the filename can be adjusted to use MRN not MIAD-ADI.

Comment from Loa: I think the filename we are considering is: draft-ietf-mpls-mna-requirements

36. In the Abstract (1)

This work is the product of the IETF MPLS Open Design Team.

Before posting as a Working Group draft, this sentence needs to be removed. It's OK to say something in the Acknowledgements.

Loa: Depending on what is meant by "before", I have a comment on this, just because info is at the wrong place it should not be considered "blocking" and could be update at any time. Personally I think working group draft version -01 would be a good place to do this update.

37. In the Abstract (2)

The term "application data" may be (is) confusing. While you probably mean it to imply an application of MPLS, it may be confused with the type of application that runs end-to-end (i.e., on a host). Although, reading some of the text, it does feel like some of the time you _are_ intending to imply that the application software may somehow be able to provide the ancillary data that is ultimately carried by MPLS.

I think, in the Abstract, you could say...

based on ancillary data that may be carried in or below the bottom of the label stack.

...but you should probably look through the rest of the text and consider the use of the word "application." Maybe one approach would be to specifically call out the term near the top of the document in order to correctly set the context.

38. In section 1 (1).

is then processed using mechanisms implemented by intermediate and/or egress LSRs that comply with the MPLS base architecture and potentially its extensions, including (but not limited to) [RFC3031], [RFC3032],[RFC6790].

This sounds like the mechanisms to process the ancillary data are already specified in those RFCs, but (of course) that's not the case.

You are probably making a point about the nodes being "MPLS" and also saying something about backward compatibility of the mechanism. But it should be clear that only nodes that contain new functionality will be able to recognise and process ancillary data.

39. In section 1 (2).

This draft specifies

Say 'document' so that you are future-proofed for publication as an RFC.

40. In section 1.1 (1)

s/an Label/a Label/ s/perfomed/performed/

41. In section 1.1 (2).

* Network Action: An operation to be performed on a packet. A network action may affect router state, packet forwarding, or it may affect the packet in some other way.

If the operation affects router state, is it really performed on the packet?

42. In section 1.1 (3)

* Network Action Indication (NAI): An indication in the packet that a certain network action is to be perfomed. There may be associated ancillary data in the packet

* Network Action Sub-Stack (NAS): A set of related, contiguous Label Stack Entries (LSEs). The first LSE contains the NAI. The TC and TTL values in the sub-stack may be redefined.

The first bullet simply says that the NAI is "in the packet", but the second bullet goes on to define where/how it is carried. I would say that it is totally irrelevant to the _requirements_ how the NAI is encoded/carried (although there may be some requirements that limit the options). But I note that there is no further mention of the NAS or of a "sub-stack". I suggest removing this second bullet.

43. In section 1.1 (4)

    * In-Stack Data: Any data within the MPLS label stack including the outer LSE and the bottom of stack (the LSE with the S-bit set).

    * Post-Stack Data: Any data beyond the LSE with the S-Bit set, but before the first octet of the user payload. This document does not prescribe whether post-stack data precedes or follows any other protocol structure such as a control word or associated channel header (ACH).

    Does "any data" mean "any ancillary data"?

44. In section 1.2 (1)

    s/number of new proposals/number of proposals/

45. In Section 1.2 (2)

    for example In-situ OAM and Service Function Chaining (SFC)

    Might benefit from references for iOAM and SFC.

46. In section 1.2 (3)

    [I-D.song-mpls-extension-header] summarises some of the issues with existing solutions to address these new applications (note that this document draws on the requirements and issues without endorsing a specific solution from [I-D.song-mpls-extension-header]):

    This gives more emphasis to the referenced draft than I think you intend. If you intend that people read that draft to see the issues, it is a normative reference. But if you are just mentioning it and have pulled the information into this document, then you need to reduce the emphasis. How about...

    [I-D.song-mpls-extension-header] sets out some of the issues in how existing solutions address these new applications. This document draws on the requirements and issues noted in that document without endorsing any specific solution.

47. Section 2

    While I understand the desire to express the requirements in definitive language, BCP14 is not about requirements. Rather it is intended to describe implementation behaviours.

A way around this that is often used is to include a subsequent paragraph such as...

Although this document is not a protocol specification, this convention is adopted for clarity of description of requirements.

See, for example, RFC 4139, RFC 4687, or RFC 5862.

48. In section 3.2 (1)

s/and indicator/an indicator/

49. In section 3.2 (2)

(2). An MPLS Network Action MUST specify whether ancillary data is required in the label stack and/or post-stack data.

Do you mean this, or do you mean that this must be specified in the documentation of the NA?

50. In section 3.2 (1)

(3). Any solution MUST respect the principle that Special Purpose Labels are the mechanism of last resort and therefore must minimise the number of new SPLs that are allocated.

Presumably a minimum here would be zero?

Loa: No we have considere this and decided that there is room to specify 1 bSPL for MNA.

Loa: I also think that we should s/Special Purpose Labels/Base Special-Purpose Labels Note: for the Extended SPLs there sare no such reestriction.

51. In section 3.2 bullet 5

s/in the way in a way/in a way/

52. In section 3.2 (bullet, 5, 6 and 10)

Bullet 10 is a wholly contained subset of bullet 5. Actually, bullet 10 is a wholly contained subset of bullet 6. Makes me think that bullets 5 and 6 possibly say the same thing as each other.

53. In section 3.2 (2)

(11). NAIs SHOULD be supported for both P2P and P2MP paths, but any specific NAI may only be supported for one or the other.

Really? You can't have an NAI that is equally applicable for both P2P and P2MP? Seems an odd restriction to impose.

54. In section 3.2 (3)

(15). NAIs can only be inserted at LERs, but MAY be processed at LSRs and LERs. If it is required to insert an NAI at a transit LSR on an LSP, then a new label stack MUST be pushed.

What does it mean to push a new label stack? If you mean that we should support "MPLS in MPLS" encapsulation so that the packet has two bottom of stack bits set, I should point out that this was previously discussed and abandoned because the presence of an LSE immediately after a set bottom of stack bit was considered unacceptable because of the assumptions made by existing hardware about what follows the bottom of stack.

55. In section 3.2 (4)

(19). Any specification of a solution that inserts or modifies the NAI MUST discuss the possible ECMP consequences.

This seems to at least partially contradict 3.2/15

It is also not clear what it means "to modify an indication in the packet that a certain network action is to be performed". I guess it means to remove the NAI?

56. In section 3.3 (1)

(3.3/1) is surely already covered by 3.3/4

57. In section 3.3 (2)

(3.3/3) seems to be unnecessary given 3.3/1

58. Semantic Routing

I think the proposal here falls in the scope of "Semantic Routing". That is, adding information to packets so that the forwarding decisions may be enhanced to act not just on the destination address or next hop label, but also on the additional information. The precise forwarding action may be known by the forwarders by definition (such as a protocol specification), installed by a routing engine according to a

routing algorithm acting on information exchanged by routing protocols, or programmed into the forwarder from a management or orchestration system.

We wrote an introduction to the idea of Semantic Routing draft-farrel-irtf-introduction-to-semantic -routing which you can look at if you want some context.

We also set out to examine the challenges and concerns introduced by Semantic Routing in draft-king-irtf-challenges-in-routing and I think it would be good if this work was calibrated against those challenges.

Loa: While semantic routing is intresting, and good be "calibrated" against MNA as a whole (guiding documents and solutions), I think it is out of scope for the requirement document.

59. Understanding of Use Cases

I would think that a more detailed an understanding of the use cases is needed before moving ahead with the requirements. I wouldn't go as far as saying that the use cases need to be referenced normatively, but I do think they need a little more attention from the WG to motivate actually adopting this work. That is, this document shows what we might need to do, but without the use cases, we would be doing it "because we can" and "because it might be useful one day." Those are not, I think really good reasons to make fairly substantial changes to deployed forwarding paradigms.

This is not to say that I dispute that there may be some valuable use cases, but that the WG needs to agree which ones are important in order to be sure that the requirements are on target.

60. Conflicting text in document

I'm puzzled that some of the text in this document appears to limit itself to cases that require ancillary data, while other parts also consider the requirements for network functions that don't require ancillary data, but do still need to be encoded in the label stack in some way. I suspect this is just editorial, but while the document title is "Requirements for MPLS Network Action Indicators and MPLS Ancillary Data" the Abstract says "This draft specifies requirements for indicators in the MPLS label stack to support ancillary data in the packet and high

level requirements on that ancillary data," and the Introduction seems entirely focused on the ancillary data case.

It would be good to be clear, at the point of adoption, which way we are jumping on this question.

draft-andersson-mpls-mna-fwk

seems to be fully behind network actions some of which may also require ancillary data.

Perhaps this document should reference that one for additional information?

61. Loa: I have been thinking about a short text (1 or 2 paragraphs) on how the guiding documents fit togehter that should appear, e.g. in the introduction of all 3 documents. It could be added later in the process, but should be there when the documents go to wglc. Let me know if there are someone that will help work on this,

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