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Use case for a scalable and topology aware MPLS data plane monitoring system
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Abstract

This document describes features and a use case of a path monitoring system. Segment based routing enables a scalbale and simple method to monitor data plane liveliness of the complete set of paths belonging to a single domain.

Table of Contents

1. Introduction

Paths looping packets through a network are not desireable for network and user data routing. The ability to execute arbitrary path combinations within a domain offers several benefits for network monitoring. A single monitoring device is able to monitor the complete set of a domains forwarding paths with OAM packets never leaving data plane. This requires topology awareness as well as a suitable security architecture. Topology awareness is an essential part of link state IGPs. Adding MPLS topology awareness to an IGP speaking device hence enables a simple and scaleable data plane monitoring mechanism.

The design of such a monitoring system should ensure that OAM packets never leave the domain they are supposed to monitor. Topology and network state awareness are useful, careful address-selection may be another one.

MPLS OAM offers flexible features to recognise an execute data paths of an MPLS domain. By utilsing the ECMP related tool set of RFC 4379 [RFC4379], a segment based routing LSP monitoring system may:

- o easily detect ECMP functionality and properties of paths at data level.
- o construct monitoring packets executing desired paths also if ECMP is present.
- o limit the MPLS label stack of an OAM packet to a minmum of 3 labels.

IPv6 related ECMP path detection and execution for OAM purposes is less powerful than that offered by MPLS OAM. This document is foscused on MPLS path monitoring.

The MPLS path monitoring system described by this document can be realised with pre-Segment based Routing (SR) technology. Making monitoring system aware of a domains complete MPLS topolfrom utilising stale MPLS label information, IGP must be monitored and MPLS topology must be timely aligned with IGP topology. Obviously, enhancing IGPs to exchange of MPLS topology information significantly simplifies and stabilises such an MPLS path monitoring system. In addition to IGP extensions, also RFC 4379 may have to be extended to support detection of SR routed paths.

Note that the MPLS path monitoring system may be a specialised system residing at a single interface of the domain to be monitored. As long as measurement packets return to this or another well specified

interface, the MPLS monitoring system is the single entity pushing monitoring packet label stacks. Concerns about router label stack pushing capabilities don't apply in this case.

2. A topology aware MPLS path monitoring system

A MPLS path monitoring system (PMS) which is able to learn all labeled paths of a domain is able to build a measurement packet which executes an arbitrary chain of paths. Such a monitoring system is aware of the MPLS topology. The task is to check liveliness of the MPLS transport path between LER i and LER j. The PMS may do so by sending packets carrying the following minimum address infomation:

- o Top Label: connected LSRs path to LER i.

- o Next Label: LER i's path to LER j.

- o Next Label or address: Data plane measurement destination at LER j (this could be a label or an IP address)

Note that the label stack could as well address MPLS node after MPLS node passed by the measurtement packet on it's path from PMS to the packets destination or any address stack between this maximum and the above minimum address information. Further, the destination could be the PSM itself. This is shown in figure.

```
                   +---+     +----+     +-----+
                   |PMS|     |LSR1|-----|LER i|
                   +---+     +----+     +-----+
                      |      /      \    /
                      |     /        \__/
                    +-----+/           /|
                    |LER m|           / |
                    +-----+\         /  \
                            \       /    \
                             \+----+     +-----+
                              |LSR2|-----|LER j|
                              +----+     +-----+
```

Example of a PMS based LSP dataplane liveness measurement

Figure 1

For the sake of simplicity, let's assume a global Node-Segment ID label space (meaning the value of a label never changes during a label swap). Let's assign the following Node SIDs to the nodes of

the figure: PMS = 10, LER i = 20, LER j = 30.

The aim is to check liveliness of the path LER i to LER j. The PMS does this by creating a measurement packet with the following label stack (top to bottom): 20 - 30 - 10.

LER m forwards the packet received from the PMS to LSR1. Assuming Pen-ultimate Hop Popping to be deployed, LSR1 pops the top label and forwards the packet to LER i. There the top label has a value 30 and LER i forwards it to LER j. This will be done transmitting the packet via LSR1 or LSR2. The LSR will again pop the top label. LER j will forward the packet now carrying the top label 10 to the PMS (and it will pass a LSR and LER m).

A few observations on the example:

- The path PMS to LER i must be stable and it must be detectable.

- If ECMP is deployed, it may be desired to measure along both possible paths, a packet may use between LER i and LER j. This may be done by using MPLS OAM coded measurement packets with suitable IP destination addresses.

- The path LER j to PMS to must be stable and it must be detectable.

To ensure reliable results, the PMS should be aware of any changes in IGP or MPLS topology.

Determining a path to be executed prior to a measurement may also be done by setting up a label including all node SIDs along that path (if LER1 has Node SID 40 in the example and it should be passed between LER i and LER j, the label stack is 20 - 40 - 30 - 10).

Obviously, the PMS is able to check and monitor data plane liveliness of all LSPs in the domain. The PMS may be a router, but could also be dedicated monitoring system. If measurement system reliability is an issue, more than a single PMS may be connected to the MPLS domain.

Monitoring an MPLS domain by a PMS based on SR offers the option of monitoring complete MPLS domains with little effort and very excellent scaleability.

3. Applying SR to monitor LDP paths

A SR based PMS connected to a MPLS domain consisting of LER and LSR supporting SR and LDP in parrallel in all nodes may use SR paths to transmit packets to and from start and end points of LDP paths to be

monitored. In the above example, the label stack top to bottom may be as follows, when sent by the PMS:

o Top: SR based Node-SID of LER i at LER m.

o Next: LDP label identifying the path to LER j at LER i.

o Bottom: SR based Node-SID identifying the path to the PMS at LER j

While the mixed operation shown here still requires the PMS to be aware of the LER LDP-MPLS topology, the PMS may learn the SR MPLS topology by IGP and use this information.

4. PMS monitoring of different Segment ID types

MPLS SR topology awareness should allow the SID to monitor liveliness of most types of SIDs (this may not be recommendable if a SID identifies an inter domain interface).

To match control plane information with data palne information, RFC4379 should be enhaced to allow collection of data relevant to check all relevant types of Segment IDs.

5. IANA Considerations

This memo includes no request to IANA.

6. Security Considerations

As mentioned in the introduction, a PMS monitoring packet should never leave the domain where it originated. It therefore should never use stale MPLS or IGP routing information. Further, asigning different label ranges for different purposes may be useful. A well known global service level range may be excluded for utilisation within PMS measurement packets. These ideas shoulddn't start a discussion. They rather should point out, that such a discussion is required when SR based OAM mechanisms like a SR are standardised.

7. References

7.1. Normative References

[RFC4379] Kompella, K. and G. Swallow, "Detecting Multi-Protocol Label Switched (MPLS) Data Plane Failures", RFC 4379,

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7.2. Informative References

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