MPLS Labels in Traceroute

Traceroute is a versatile tool that is frequently used to troubleshoot problems on the Internet. An excellent presentation is given in NANOG 47 meeting where a lot of real use cases are demystified.

When analysing MPLS deployments on the Internet, traceroute can also be helpful. Thanks to the support of ICMP Extensions for Multiprotocol Label Switching, MPLS Label Switching Routers (LSR) append MPLS information to ICMP messages. Selected ICMP messages include the MPLS label stack, as it arrived at the router that is sending the ICMP message.

For example, a traceroute to `www.univ-rennes1.fr` reveals the different hops toward the destination:

```
$ traceroute -P icmp www.univ-rennes1.fr
traceroute to frontalhttp.univ-rennes1.fr (129.20.126.100), 64 hops max, 72
byte packets
 1  neufbox (192.168.1.1)  1.804 ms  1.718 ms  1.510 ms
 2  129.112.16.109.rev.sfr.net (109.16.112.129)  28.440 ms  34.535 ms
28.499 ms
 3  77.56.66.86.rev.sfr.net (86.66.56.77)  28.384 ms  29.678 ms  27.561 ms
 4  185.73.66.86.rev.sfr.net (86.66.73.185)  30.758 ms  30.744 ms  29.597 ms
 5  renater-ix1.sfinx.tm.fr (194.68.129.102)  37.389 ms  38.937 ms  41.514
ms
 6  te4-2-rouen-rtr-021.noc.renater.fr (193.51.189.50)  41.297 ms  42.737 ms
*
 7  te4-2-caen-rtr-021.noc.renater.fr (193.51.189.45)  42.710 ms  41.381 ms
40.157 ms
 8  te1-5-rennes-rtr-021.noc.renater.fr (193.51.189.53)  42.530 ms  43.130
ms  43.615 ms
 9  * u-1-rennes-cri-gi8-1-rennes-rtr-021.noc.renater.fr (193.51.184.25)
46.353 ms  41.514 ms
10  frontalhttp.univ-rennes1.fr (129.20.126.100)  42.702 ms  41.322 ms
42.429 ms
```

Examining the detail of the received ICMP TTL exceeded packets with Wireshark reveals an ICMP Mutli-part extension that carries the MPLS label.

```
No.     Time           Source                Destination           Protocol
Length Info
    41 5.947446000    193.51.189.50         192.168.1.24          ICMP
182    Time-to-live exceeded (Time to live exceeded in transit)

Internet Control Message Protocol
    Type: 11 (Time-to-live exceeded)
    Code: 0 (Time to live exceeded in transit)
    Checksum: 0x3974 [correct]
    Internet Protocol Version 4, Src: 192.168.1.24 (192.168.1.24), Dst:
131.254.254.131 (131.254.254.131)
    User Datagram Protocol, Src Port: 46416 (46416), Dst Port: 33452 (33452)
```

```
    Data (24 bytes)
    ICMP Multi-Part Extensions
        Version: 2
        Reserved: 0x000
        Checksum: 0x8df2 [correct]
        MPLS Stack Entry
            Length: 8
            Class: 1
            C-Type: 1
            Label: 53, Exp: 0, S: 1, TTL: 1
                0000 0000 0000 0011 0101 .... = Label: 53
                .... .... .... .... .... 000. = Experimental: 0
                .... .... .... .... .... ...1 = Stack bit: Set
                Time to live: 1
```

MTR is an adapted tool for capturing the MPLS label switching:

```
$mtr -e www.univ-rennes1.fr
 1. neufbox
 2. 129.112.16.109.rev.sfr.net
 3. 77.56.66.86.rev.sfr.net
 4. 185.73.66.86.rev.sfr.net
 5. renater-ix1.sfinx.tm.fr
 6. te4-2-rouen-rtr-021.noc.renater.fr
    [MPLS: Lbl 53 Exp 0 S 1 TTL 1]
 7. te4-2-caen-rtr-021.noc.renater.fr
    [MPLS: Lbl 546 Exp 0 S 1 TTL 1]
 8. te1-5-rennes-rtr-021.noc.renater.fr
 9. u-1-rennes-cri-gi8-1-rennes-rtr-021.noc.renater.fr
10. frontalhttp.univ-rennes1.fr
```

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Last update: **2014/02/08 17:32**