INTERNATIONAL TELECOMMUNICATION UNION

**TELECOMMUNICATION STANDARDIZATION SECTOR**

STUDY PERIOD 2017-2020

**SG11-TD1604/GEN**

**STUDY GROUP 11**

**Original: English**

**Question(s):** 13/11 Virtual, 17-26 March 2021

**TD**

**Source:** Editors

**Title:** Output - baseline text for a new work item Q.joint_tr “Requirements and Reference Model for optimized traceroute of joint IP/MPLS” (virtual, 17-26 March 2021)

**Purpose:** Information

**Contact:** Cancan Huang
China Telecom
P.R.China
Tel: +86 20 38639366
Fax: +86 20 38639489
Email: huangcanc@chinatelecom.cn

**Contact:** Minrui Shi
China Telecom
China
Tel: 021-68540571
Fax: 021-68540557
Email: shimr@chinatelecom.cn

**Contact:** Xu Lu
CAICT,MIIT
China
Tel: +86 10 62301271
Fax: +86 10 62301383
Email: luxu@caict.ac.cn

**Contact:** Yongsheng Liu
China Unicom
China
Tel: +86 10 18601106253
Email: liuys170@chinaunicom.cn

**Keywords:** IP/MPLS; ICMP traceroute ;

**Abstract:** This document is the initial baseline text for a new work item Q.joint_tr “Requirements and Reference model for optimized traceroute of joint IP/MPLS”. It includes the discussion results in the Q13/11 meeting held at Virtual, 17-26 March 2021.

This document is the initial output of draft Recommendation Q.joint_tr "Requirements and Reference model for optimized traceroute of joint IP/MPLS".

The following table shows discussion results for contributions.

| Document Number | Source | Title | Meeting results |
|---|---|---|---|
| C0592 | China Telecom,<br>Ministry of Industry and Information Technology (MIIT) China,<br>China Unicom | Proposal to start a new work item - ITU-T Q.joint_tr "Requirements and Reference Model for optimized traceroute of joint IP/MPLS" | Accepted with modifications |

**Draft new Recommendation ITU-T Q.joint_tr**

# Requirements and Reference Model for optimized traceroute of joint IP/MPLS

## Summary

This draft recommendation describes the requirements and reference model for optimized traceroute for joint IP/MPLS.

## Keywords

IP/MPLS; ICMP traceroute ;

## Introduction

## Table of Contents

**Draft Recommendation ITU-T Q.joint_tr**

**Requirements and Reference Model for Optimized Traceroute for joint IP/MPLS**

## 1 Scope

The scope of this Recommendation consists of:

(1) Requirements of route tracing of joint IP/MPLS;

(2) Methods of optimized traceroute of joint IP/MPLS;

(3) Reference Model for optimized traceroute of joint IP/MPLS;

## 2 References

## 3 Definitions

### 3.1 Terms defined elsewhere

### 3.2 Terms defined in this Recommendation

## 4 Abbreviations and acronyms

MPLS Multiple Protocol Label Switch

IP Internet Protocol

ICMP Internet Control Message Protocol

LFIB Label Forwarding Information Base

## 5 Conventions

## 6 Requirements of Route Tracing of Enterprise Network

TBD

## 7 Methods of Route Tracing of Enterprise Network

### 7.1 Current route tracing of joint IP/MPLS

There are several service scenarios use joint IP/MPLS.”joint” here means that in one specific level of ISO model, the end-to-end path is joint by several sections using different technologies. Fig 1 show a typical end-to-end enterprise network.In this scenario,customer CE access to the carrier network using IP protocol. Within the carrier’s network, the carrier uses MPLS technologies to transfer enterprise’s packets. So it is a typical service that jointly use different protocols(IP and MPLS).

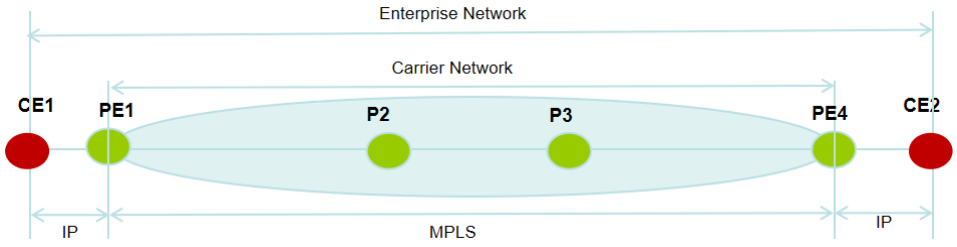


Fig 7-1 Enterprise Network through carrier’s MPLS network

Within such scenario, the current route tracing technology is ICMP.Here is a simple example which explains the behavior when ICMP trace is triggered from CE1 to remote CE2 over MPLS domain.

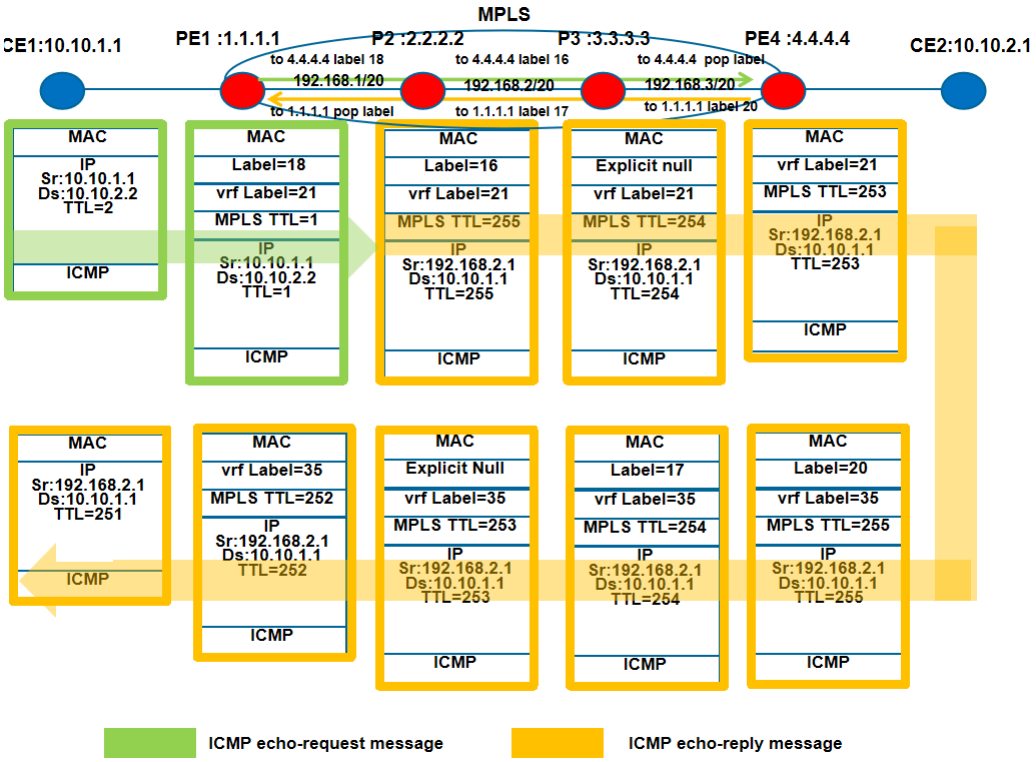


Fig 7-2 ICMP pattern of TTL=2 for End-to-End Enterprise Network

Here is a simple example which explains the behavior when ICMP trace is triggered from CE1 to remote CE2 over MPLS domain:

In this topology, when ICMP traceroute is triggered from CE1 to CE2, the first packet is sent with TTL of 1. This is normal IP packet and so PE1 follows the traditional behavior of generating ICMP and sending directly to CE1. The second packet sent with TTL=2 will expire at P2.

P2 will buffer the label stack and generate ICMP error message and include the incoming label stack from the buffer in ICMP payload. It further populate the IP header with source address from incoming interface(192.168.2.1) of the labeled packet, destination address as the source of the labeled packet(10.10.1.1). The TTL is set to 255. It now pushes the label stack from the buffer and consults the LFIB table for forwarding action on top label. In the above topology for example, the received label stack is {18, 21}. On performing a lookup in LFIB table for top label, 18 will be swapped with label 16 and will be forwarded towards nexthop P3. P3 in turn will pop the top label and forward to PE4. PE4 will use the VRF label 21 to identify the VRF and forward the packet back towards CE1(outer label =20,vrf label=35).

In this way, the ICMP packet is not sent back to CE1 directly from P2. Instead, this ICMP packet generated from p2 is firstly steered to the end point of MPLS VPN tunnel PE4 and then steered back to CE1 from PE4. The drawbacks of this method are obvious:

(1) The packet takes a long journey with a big circle to reach the destination.It not only cost a large time-delay but also waste the bandwidth from P2 to PE4.

(2) Most seriously, the statistic of delay reflected from P2 to CE1 is totally incorrect.It cannot provide the time cost data between P2 and CE1 and consequently it is meaningless.

## 7.2 Optimized traceroute for joint IP/MPLS

It is essential to directly steer the ICMP echo-reply message from tested node to the source node. And it is the only method to test the real time consuming between the two nodes.

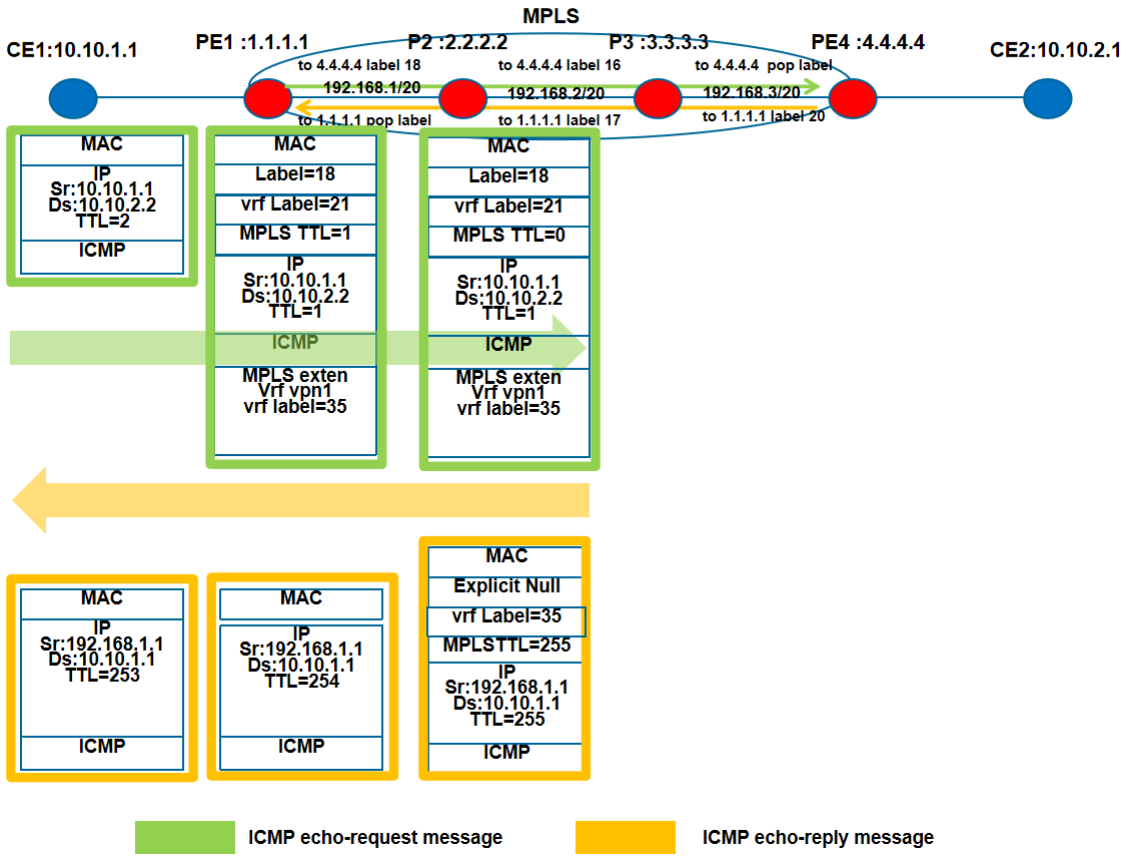


Fig 3 Optimized ICMP pattern of TTL=2 for End-to-End Enterprise Network

In this topology, when ICMP traceroute is triggered from CE1 to CE2, the second packet is sent with TTL of 2 and will expire at P2.

When ICMP echo-request packets arrives at PE1, PE1 will check the source IP address 10.10.1.1 from vrf routing table, and found it is mapped to vrf “vpn1”. Then PE1 will find out:

1) The vrf out-going label 21 and incoming label 35 in vrf “vpn1” LFIB
2) The vrf vpn1 endpoint PE4(4.4.4.4) and the top label 18.

PE1 encapsulate the ICMP echo-request packets with MPLS header including top label, vrf label and TTL information(here TTL=1). In this method, ICMP should be extended to carry more MPLS information,the incoming vrf label 35 and the source end of mpls vpn tunnel 1.1.1.1(PE1) should be added to the packet to give more information for next-hop node.

When the restructured packets arrives at P2, the TTL decrease to 0, and P2 will generate ICMP error message(echo-reply message). P2 first check the source IP address carried in ICMP payload. Then P2 check the LFIB and find out 1.1.1.1 mapping to label “Explicit Null”. So it added none to MPLS top label field and set the TTL=255. Then P2 set vrf label=35 to vrf label field. P2 set source IP address to 192.168.1.1 the IP address of the interface the packets steered in, and set destination IP address to 10.10.1.1 as the source of the labeled packet. The packet could be steered to PE1(1.1.1.1) directly in this way.

When PE1 receives the packets from P2, it pops the vrf label 35,check the LFIB and find out that this vrf label mapping to vrf name “vpn1”. Then it check the FIB of “vpn1” and find the outgoing interface to go to the destination 10.10.1.1 and redirect the ICMP the packet to that interface.

Through this optimized method, P2 is able to generate the ICMP packets in a better way to make a direct throw between tested node and source node. Consequently an accurate traceroute statistic could be collected and the network resources(like bandwidth) are saved.

## 8 Reference Model of Optimized traceroute for joint IP/MPLS

TBD

_____