

MSR 系列路由器 MPLS TE 双向链路保护 FRR 功能的典型配置举例

Copyright © 2014 杭州华三通信技术有限公司 版权所有，保留一切权利。
非经本公司书面许可，任何单位和个人不得擅自摘抄、复制本文档内容的部分或全部，
并不得以任何形式传播。本文档中的信息可能变动，恕不另行通知。

The H3C logo is displayed in a bold, red, sans-serif font. The letters 'H', '3', and 'C' are connected, with the '3' being slightly smaller and positioned between the 'H' and 'C'.

目 录

1 简介	1
2 配置前提	1
3 配置举例	1
3.1 组网需求	1
3.2 配置思路	2
3.3 使用版本	2
3.4 配置步骤	2
3.4.1 设备Router A配置	2
3.4.2 设备Router B配置	4
3.4.3 设备Router C配置	5
3.5 验证配置	8
3.6 配置文件	11
4 相关资料	15

1 简介

本文档介绍使用 MPLS TE 双向链路保护 FRR 功能的典型案例。

2 配置前提

本文档不严格与具体软、硬件版本对应，如果使用过程中与产品实际情况有差异，请参考相关产品手册，或以设备实际情况为准。

本文档中的配置均是在实验室环境下进行的配置和验证，配置前设备的所有参数均采用出厂时的缺省配置。如果您已经对设备进行了配置，为了保证配置效果，请确认现有配置和以下举例中的配置不冲突。

本文档假设您已了解 MPLS TE 的 FRR 功能特性。

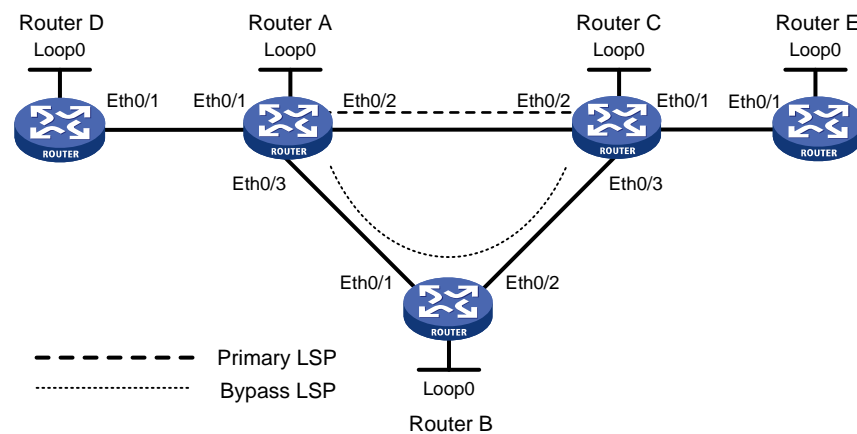
3 配置举例

3.1 组网需求

如 [图 1](#) 所示，在 MPLS 骨干网中，从 Router A 到 Router C 建立 MPLS TE 隧道 Primary LSP，由 Router D 到 Router E 的报文优先选择 Primary LSP 进行转发。要求：

- 建立一条备份 MPLS TE 隧道 Bypass LSP，当 Primary LSP 中断时，自动快速重路由到备份隧道 Bypass LSP。
- MPLS TE 隧道使用显式路径方式。

图1 MSR 系列路由器 MPLS TE 双向链路保护 FRR 功能配置组网图



设备	接口	IP地址	设备	接口	IP地址
Router A	Loop0	1.1.1.1/32	Router B	Loop0	2.2.2.2/32
	Eth0/1	192.168.1.1/24		Eth0/1	1.0.0.2/24
	Eth0/2	3.0.0.1/24		Eth0/2	2.0.0.1/24
	Eth0/3	1.0.0.1/24	Router D	Loop0	4.4.4.4/32
Router C	Loop0	3.3.3.3/32	Router E	Loop0	5.5.5.5/32
	Eth0/1	192.168.2.1/24		Eth0/1	192.168.2.2/24
	Eth0/2	3.0.0.2/24			
	Eth0/3	2.0.0.2/24			

3.2 配置思路

为了使数据报文在 Primary LSP 中断后快速重路由到 Bypass LSP，需要将 Bypass LSP 绑定到被保护的接口，使得被保护接口中断时触发 Bypass LSP。

在配置 MPLS TE 隧道时，由于 MPLS TE 的 LSP 隧道是单向的，因此需要在 Router A 和 Router C 都向对方建立 LSP，只有双向 LSP 都建立成功，发送给对方的报文才能正常转发回来。

3.3 使用版本

本举例是在 Release 2311 版本上进行配置和验证的。

3.4 配置步骤

3.4.1 设备Router A配置

配置设备接口地址。

```
<RouterA> system-view
[RouterA] interface loopback 0
[RouterA-LoopBack0] ip address 1.1.1.1 255.255.255.255
[RouterA-LoopBack0] quit
[RouterA] interface ethernet 0/1
[RouterA-Ethernet0/1] ip address 192.168.1.1 255.255.255.0
[RouterA-Ethernet0/1] quit
[RouterA] interface ethernet 0/2
[RouterA-Ethernet0/2] ip address 3.0.0.1 255.255.255.0
[RouterA-Ethernet0/2] quit
[RouterA] interface ethernet 0/3
[RouterA-Ethernet0/3] ip address 1.0.0.1 255.255.255.0
[RouterA-Ethernet0/3] quit
```

配置 OSPF 协议，使网络互通。

```
[RouterA] ospf 1
[RouterA-ospf-1] area 0.0.0.0
[RouterA-ospf-1-area-0.0.0.0] network 1.1.1.1 0.0.0.0
[RouterA-ospf-1-area-0.0.0.0] network 1.0.0.0 0.0.0.255
[RouterA-ospf-1-area-0.0.0.0] network 3.0.0.0 0.0.0.255
[RouterA-ospf-1-area-0.0.0.0] quit
[RouterA-ospf-1] quit
```

配置 MPLS LSR-ID，使能 MPLS TE 和 RSVP-TE。

```
[RouterA] router id 3.3.3.3
[RouterA] mpls lsr-id 3.3.3.3
[RouterA] mpls
[RouterA-mpls] mpls te
[RouterA-mpls] mpls te timer fast-reroute 1
[RouterA-mpls] mpls rsvp-te
```

```
[RouterA-mpls] mpls te cspf
```

```
[RouterA-mpls] quit
```

在接口使能 MPLS 基本能力，MPLS TE 和 REVP-TE，并配置转发 MPLS TE 流量的链路最大带宽和最大可预留带宽。

```
[RouterA] interface ethernet 0/2
```

```
[RouterA-Ethernet0/2] mpls
```

```
[RouterA-Ethernet0/2] mpls te
```

```
[RouterA-Ethernet0/2] mpls te max-link-bandwidth 50000
```

```
[RouterA-Ethernet0/2] mpls te max-reservable-bandwidth 50000
```

```
[RouterA-Ethernet0/2] mpls rsvp-te
```

```
[RouterA-Ethernet0/2] quit
```

```
[RouterA] interface ethernet 0/3
```

```
[RouterA-Ethernet0/3] mpls
```

```
[RouterA-Ethernet0/3] mpls te
```

```
[RouterA-Ethernet0/3] mpls te max-link-bandwidth 50000
```

```
[RouterA-Ethernet0/3] mpls te max-reservable-bandwidth 50000
```

```
[RouterA-Ethernet0/3] mpls rsvp-te
```

```
[RouterA-Ethernet0/3] quit
```

使能 Opaque LSA 能力。

```
[RouterA] ospf 1
```

```
[RouterA-ospf-1] opaque-capability enable
```

```
[RouterA-ospf-1] area 0.0.0.0
```

使能 OSPF TE

```
[RouterA-ospf-1-area-0.0.0.0] mpls-te enable
```

```
[RouterA-ospf-1-area-0.0.0.0] quit
```

```
[RouterA-ospf-1] quit
```

配置主 LSP 的显式路径 primary。

```
[RouterA] explicit-path primary
```

```
[RouterA-explicit-path-primary] next hop 3.0.0.2
```

```
[RouterA-explicit-path-primary] next hop 3.3.3.3
```

```
[RouterA-explicit-path-primary] quit
```

配置主 LSP。

```
[RouterA] interface tunnel 0
```

```
[RouterA-Tunnel0] ip address 10.0.0.1 255.255.255.252
```

```
[RouterA-Tunnel0] tunnel-protocol mpls te
```

```
[RouterA-Tunnel0] destination 3.3.3.3
```

```
[RouterA-Tunnel0] mpls te tunnel-id 10
```

```
[RouterA-Tunnel0] mpls te record-route label
```

```
[RouterA-Tunnel0] mpls te bandwidth ct0 30000
```

#设置隧道优先级为 1。

```
[RouterA-Tunnel0] mpls te path explicit-path primary preference 1
```

使能 FRR。

```
[RouterA-Tunnel0] mpls te fast-reroute
```

```
[RouterA-Tunnel0] mpls te commit
```

```
[RouterA-Tunnel0] quit
```

配置 Bypass LSP 的显式路径 bypass。

```
[RouterA-mpls] explicit-path bypass
[RouterA-explicit-path-bypass] next hop 1.0.0.2
[RouterA-explicit-path-bypass] next hop 2.0.0.2
[RouterA-explicit-path-bypass] next hop 3.3.3.3
[RouterA-explicit-path-bypass] quit
```

配置 Bypass LSP。

```
[RouterA] interface tunnel 1
[RouterA-Tunnel1] ip address 20.0.0.1 255.255.255.252
[RouterA-Tunnel1] tunnel-protocol mpls te
[RouterA-Tunnel1] destination 3.3.3.3
[RouterA-Tunnel1] mpls te tunnel-id 20
[RouterA-Tunnel1] mpls te record-route label
[RouterA-Tunnel1] mpls te bandwidth ct0 30000
```

设置隧道优先级为 2。

```
[RouterA-Tunnel1] mpls te path explicit-path bypass preference 2
```

配置 Bypass LSP 可保护的带宽。

```
[RouterA-Tunnel1] mpls te backup bandwidth 20000
[RouterA-Tunnel1] mpls te commit
[RouterA-Tunnel1] quit
```

将备份 MPLS TE 隧道绑定到被保护的接口。

```
[RouterA] interface ethernet 0/2
[RouterA-Ethernet0/2] mpls te fast-reroute bypass-tunnel tunnel 1
[RouterA-Ethernet0/2] quit
```

配置通过 Tunnel 隧道到 192.168.2.0/24 的静态路由，并配置高于 OSPF 的优先级。

```
[RouterA] ip route-static 192.168.2.0 255.0.0.0 tunnel0 preference 1
[RouterA] ip route-static 192.168.2.0 255.0.0.0 tunnel1 preference 2
```

3.4.2 设备 Router B 配置

配置设备接口地址。

```
<RouterB> system-view
[RouterB] interface loopback 0
[RouterB-LoopBack0] ip address 2.2.2.2 255.255.255.255
[RouterB-LoopBack0] quit
[RouterB] interface ethernet 0/1
[RouterB-Ethernet0/1] port link-mode route
[RouterB-Ethernet0/1] ip address 1.0.0.2 255.255.255.0
[RouterB-Ethernet0/1] quit
[RouterB] interface ethernet 0/2
[RouterB-Ethernet0/2] port link-mode route
[RouterB-Ethernet0/2] ip address 2.0.0.1 255.255.255.0
[RouterB-Ethernet0/2] quit
```

配置 OSPF 协议，使网络互通。

```
[RouterB] ospf 1
[RouterB-ospf-1] area 0.0.0.0
```

```
[RouterB-ospf-1-area-0.0.0.0] network 2.2.2.2 0.0.0.0
[RouterB-ospf-1-area-0.0.0.0] network 1.0.0.0 0.0.0.255
[RouterB-ospf-1-area-0.0.0.0] network 2.0.0.0 0.0.0.255
RouterB-ospf-1-area-0.0.0.0] quit
[RouterB-ospf-1] quit
```

配置 MPLS LSR-ID, 使能 MPLS TE 和 RSVP-TE。

```
[RouterB] router id 2.2.2.2
[RouterB] mpls lsr-id 2.2.2.2
[RouterB] mpls
[RouterB-mpls] mpls te
[RouterB-mpls] mpls rsvp-te
[RouterB-mpls] mpls te cspf
[RouterB-mpls] quit
```

在接口使能 MPLS 基本能力, MPLS TE 和 REVP-TE, 并配置转发 MPLS TE 流量的链路最大带宽和最大可预留带宽。

```
[RouterB] interface ethernet 0/1
[RouterB-Ethernet0/1] mpls
[RouterB-Ethernet0/1] mpls te
[RouterB-Ethernet0/1] mpls rsvp-te
[RouterB-Ethernet0/1] quit
[RouterB] interface ethernet 0/2
[RouterB-Ethernet0/2] mpls
[RouterB-Ethernet0/2] mpls te
[RouterB-Ethernet0/2] mpls rsvp-te
[RouterB-Ethernet0/2] quit
```

使能 Opaque LSA 能力。

```
[RouterB] ospf 1
[RouterB-ospf-1] opaque-capability enable
[RouterB-ospf-1] area 0.0.0.0
[RouterB-ospf-1-area-0.0.0.0] mpls-te enable
[RouterB-ospf-1-area-0.0.0.0] quit
[RouterB-ospf-1] quit
```

3.4.3 设备Router C配置

配置设备接口地址。

```
<RouterC> system-view
[RouterC] interface loopback 0
[RouterC-LoopBack0] ip address 3.3.3.3 255.255.255.255
[RouterC-LoopBack0] quit
[RouterC] interface ethernet 0/1
[RouterC-Ethernet0/1] port link-mode route
[RouterC-Ethernet0/1] ip address 192.168.2.1 255.255.255.0
[RouterC-Ethernet0/1] quit
[RouterC] interface ethernet 0/2
[RouterC-Ethernet0/2] port link-mode route
[RouterC-Ethernet0/2] ip address 3.0.0.2 255.255.255.0
```

```
[RouterC-Ethernet0/2] quit
[RouterC] interface ethernet 0/3
[RouterC-Ethernet0/3] port link-mode route
[RouterC-Ethernet0/3] ip address 2.0.0.2 255.255.255.0
[RouterC-Ethernet0/3] quit
```

配置 OSPF 协议，使网络互通。

```
[RouterC] ospf 1
[RouterC-ospf-1] area 0.0.0.0
[RouterC-ospf-1-area-0.0.0.0] network 3.3.3.3 0.0.0.0
[RouterC-ospf-1-area-0.0.0.0] network 3.0.0.0 0.0.0.255
[RouterC-ospf-1-area-0.0.0.0] network 2.0.0.0 0.0.0.255
[RouterC-ospf-1-area-0.0.0.0] quit
[RouterC-ospf-1] quit
```

配置 MPLS LSR-ID，使能 MPLS TE 和 RSVP-TE。

```
[RouterC] router id 3.3.3.3
[RouterC] mpls lsr-id 3.3.3.3
[RouterC] mpls
[RouterC-mpls] mpls te
[RouterC-mpls] mpls te timer fast-reroute 1
[RouterC-mpls] mpls te cspf
[RouterC-mpls] quit
```

在接口使能 MPLS 基本能力，MPLS TE 和 REVP-TE，并配置转发 MPLS TE 流量的链路最大带宽和最大可预留带宽。

```
[RouterC] interface ethernet 0/2
[RouterC-Ethernet0/2] mpls
[RouterC-Ethernet0/2] mpls te
[RouterC-Ethernet0/2] mpls rsvp-te
[RouterC-Ethernet0/2] mpls te max-link-bandwidth 50000
[RouterC-Ethernet0/2] mpls te max-reservable-bandwidth 50000
[RouterC-Ethernet0/2] quit
[RouterC] interface ethernet 0/3
[RouterC-Ethernet0/3] mpls
[RouterC-Ethernet0/3] mpls te
[RouterC-Ethernet0/3] mpls rsvp-te
[RouterC-Ethernet0/3] mpls te max-link-bandwidth 50000
[RouterC-Ethernet0/3] mpls te max-reservable-bandwidth 50000
[RouterC-Ethernet0/3] quit
```

使能 Opaque LSA 能力。

```
[RouterC] ospf 1
[RouterC-ospf-1] opaque-capability enable
[RouterC-ospf-1] area 0.0.0.0
[RouterC-ospf-1-area-0.0.0.0] mpls-te enable
[RouterC-ospf-1-area-0.0.0.0] quit
[RouterC-ospf-1] quit
```

配置主 LSP 的显式路径 primary。

```
[RouterC] explicit-path primary
```



```
[RouterC-explicit-path-primary] next hop 3.0.0.1
[RouterC-explicit-path-primary] next hop 1.1.1.1
[RouterC-explicit-path-primary] quit
```

配置主 LSP。

```
[RouterC] interface tunnel 0
[RouterC-Tunnel0] ip address 10.0.0.2 255.255.255.252
[RouterC-Tunnel0] tunnel-protocol mpls te
[RouterC-Tunnel0] destination 1.1.1.1
[RouterC-Tunnel0] mpls te tunnel-id 10
[RouterC-Tunnel0] mpls te record-route label
[RouterC-Tunnel0] mpls te bandwidth ct0 30000
```

#设置隧道优先级为 1。

```
[RouterC-Tunnel0] mpls te path explicit-path primary preference 1
```

使能 FRR。

```
[RouterC-Tunnel0] mpls te fast-reroute
[RouterC-Tunnel0] mpls te commit
[RouterC-Tunnel0] quit
```

配置 Bypass LSP 的显式路径 bypass。

```
[RouterC] explicit-path bypass
[RouterC-explicit-path-bypass] next hop 2.0.0.1
[RouterC-explicit-path-bypass] next hop 1.0.0.1
[RouterC-explicit-path-bypass] next hop 1.1.1.1
[RouterC-explicit-path-bypass] quit
```

配置 Bypass LSP。

```
[RouterC] interface tunnel 1
[RouterC-Tunnel1] ip address 20.0.0.2 255.255.255.252
[RouterC-Tunnel1] tunnel-protocol mpls te
[RouterC-Tunnel1] destination 1.1.1.1
[RouterC-Tunnel1] mpls te tunnel-id 20
[RouterC-Tunnel1] mpls te record-route label
[RouterC-Tunnel1] mpls te bandwidth ct0 30000
```

#设置隧道优先级为 2。

```
[RouterC-Tunnel1] mpls te path explicit-path RouterB preference 2
```

```
[RouterC-Tunnel1] quit
```

配置 Bypass LSP 可保护的带宽。

```
[RouterC] mpls te backup bandwidth 20000
[RouterC-Tunnel1] mpls te commit
[RouterC-Tunnel1] quit
```

将 Bypass LSP 绑定到被保护的接口。

```
[RouterC] interface ethernet 0/2
[RouterC-Ethernet0/2] mpls te fast-reroute bypass-tunnel tunnel1
[RouterC-Ethernet0/2] quit
```

配置通过 Tunnel 隧道到 192.168.2.0/24 的静态路由，并配置高于 OSPF 的优先级。

```
[RouterC] ip route-static 192.168.1.0 255.255.255.0 tunnel0 preference 1
[RouterC] ip route-static 192.168.1.0 255.255.255.0 tunnel1 preference 2
```

3.5 验证配置

在 Router A 上执行 `display mpls lsp` 命令，可以看到 LSP 表项

```
<RouterA> display mpls lsp
-----
                        LSP Information: RSVP LSP
-----
FEC                    In/Out Label  In/Out IF                    Vrf Name
3.3.3.3/32             NULL/1024  -/GE0/1
1.1.1.1/32             3/NULL    GE0/1/-
3.3.3.3/32             NULL/3     -/GE1/7
1.1.1.1/32             3/NULL    GE1/7/-
```

在 Router A 执行 `display mpls te tunnel` 命令，可以看到隧道的建立情况，有两条隧道经过。

```
<RouterA> display mpls te tunnel
LSP-Id                 Destination                In/Out-If                  Name
1.1.1.1:58             3.3.3.3                   -/GE0/1                   Tunnel1
3.3.3.3:77             1.1.1.1                   GE0/1/-                   Tunnel1
1.1.1.1:59             3.3.3.3                   -/GE1/7                   Tunnel0
3.3.3.3:78             1.1.1.1                   GE1/7/-                   Tunnel0
```

在 Router A 上执行 `display interface tunnel` 命令。

```
<RouterA> display interface tunnel
Tunnel0 current state: UP
Line protocol current state: UP
Description: Tunnel0 Interface
The Maximum Transmit Unit is 64000
Internet Address is 10.0.0.1/30 Primary
Encapsulation is TUNNEL, service-loopback-group ID not set.
Tunnel source unknown, destination 3.3.3.3
Tunnel bandwidth 64 (kbps)
Tunnel protocol/transport CR_LSP
Output queue : (Urgent queuing : Size/Length/Discards) 0/100/0
Output queue : (Protocol queuing : Size/Length/Discards) 0/500/0
Output queue : (FIFO queuing : Size/Length/Discards) 0/75/0
Last clearing of counters: Never
  Last 300 seconds input: 0 bytes/sec, 0 packets/sec
  Last 300 seconds output: 1 bytes/sec, 0 packets/sec
  0 packets input, 0 bytes
  0 input error
  35 packets output, 2940 bytes
  0 output error

Tunnel1 current state: UP
Line protocol current state: UP
Description: Tunnel1 Interface
The Maximum Transmit Unit is 64000
Internet Address is 20.0.0.1/30 Primary
Encapsulation is TUNNEL, service-loopback-group ID not set.
```

```
Tunnel source unknown, destination 3.3.3.3
Tunnel bandwidth 64 (kbps)
Tunnel protocol/transport CR_LSP
Output queue : (Urgent queuing : Size/Length/Discards) 0/100/0
Output queue : (Protocol queuing : Size/Length/Discards) 0/500/0
Output queue : (FIFO queuing : Size/Length/Discards) 0/75/0
Last clearing of counters: Never
  Last 300 seconds input: 0 bytes/sec, 0 packets/sec
  Last 300 seconds output: 1 bytes/sec, 0 packets/sec
  0 packets input, 0 bytes
  0 input error
  15 packets output, 1300 bytes
  0 output error
```

从 Router D 上 ping Router E 的接口 Ethernet0/1 地址，查看能否 ping 通。

```
<RouterD> ping 192.168.2.2
PING 192.168.2.2: 56 data bytes, press CTRL_C to break
  Reply from 192.168.2.2: bytes=56 Sequence=0 ttl=252 time=1 ms
  Reply from 192.168.2.2: bytes=56 Sequence=1 ttl=252 time=1 ms
  Reply from 192.168.2.2: bytes=56 Sequence=2 ttl=252 time=1 ms
  Reply from 192.168.2.2: bytes=56 Sequence=3 ttl=252 time=1 ms
  Reply from 192.168.2.2: bytes=56 Sequence=4 ttl=252 time=1 ms

--- 192.168.2.2 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 1/1/1 ms
```

继续在 Router A 上执行 display interface tunnel 命令，观察到数据包是经由 Tunnel 0 发送给目的地址。

```
<RouterA> display interface tunnel
Tunnel0 current state: UP
Line protocol current state: UP
Description: Tunnel0 Interface
The Maximum Transmit Unit is 64000
Internet Address is 10.0.0.1/30 Primary
Encapsulation is TUNNEL, service-loopback-group ID not set.
Tunnel source unknown, destination 3.3.3.3
Tunnel bandwidth 64 (kbps)
Tunnel protocol/transport CR_LSP
Output queue : (Urgent queuing : Size/Length/Discards) 0/100/0
Output queue : (Protocol queuing : Size/Length/Discards) 0/500/0
Output queue : (FIFO queuing : Size/Length/Discards) 0/75/0
Last clearing of counters: Never
  Last 300 seconds input: 0 bytes/sec, 0 packets/sec
  Last 300 seconds output: 0 bytes/sec, 0 packets/sec
  0 packets input, 0 bytes
  0 input error
  40 packets output, 3360 bytes
```

0 output error

```
Tunnell current state: UP
Line protocol current state: UP
Description: Tunnell Interface
The Maximum Transmit Unit is 64000
Internet Address is 20.0.0.1/30 Primary
Encapsulation is TUNNEL, service-loopback-group ID not set.
Tunnel source unknown, destination 3.3.3.3
Tunnel bandwidth 64 (kbps)
Tunnel protocol/transport CR_LSP
Output queue : (Urgent queuing : Size/Length/Discards) 0/100/0
Output queue : (Protocol queuing : Size/Length/Discards) 0/500/0
Output queue : (FIFO queuing : Size/Length/Discards) 0/75/0
Last clearing of counters: Never
  Last 300 seconds input: 0 bytes/sec, 0 packets/sec
  Last 300 seconds output: 0 bytes/sec, 0 packets/sec
  0 packets input, 0 bytes
  0 input error
  15 packets output, 1300 bytes
  0 output error
```

在 Router A 上关闭接口 Ethernet0/2

```
[RouterA] interface Ethernet0/2
[RouterA-Ethernet0/2] shutdown
[RouterA-Ethernet0/2] quit
```

再从 Router D 上 ping Router E 的接口 Ethernet0/1 地址, 然后在 Router A 上执行 display interface tunnel 命令, 观察到数据包是经由 Tunnel 1 发送给目的地址。

```
<RouterA> display interface tunnel
Tunnel0 current state: DOWN
Line protocol current state: DOWN
Description: Tunnel0 Interface
The Maximum Transmit Unit is 64000
Internet Address is 10.0.0.1/30 Primary
Encapsulation is TUNNEL, service-loopback-group ID not set.
Tunnel source unknown, destination 3.3.3.3
Tunnel bandwidth 64 (kbps)
Tunnel protocol/transport CR_LSP
Output queue : (Urgent queuing : Size/Length/Discards) 0/100/0
Output queue : (Protocol queuing : Size/Length/Discards) 0/500/0
Output queue : (FIFO queuing : Size/Length/Discards) 0/75/0
Last clearing of counters: Never
  Last 300 seconds input: 0 bytes/sec, 0 packets/sec
  Last 300 seconds output: 0 bytes/sec, 0 packets/sec
  0 packets input, 0 bytes
  0 input error
  40 packets output, 3360 bytes
  0 output error
```

```

Tunnell current state: UP
Line protocol current state: UP
Description: Tunnell Interface
The Maximum Transmit Unit is 64000
Internet Address is 20.0.0.1/30 Primary
Encapsulation is TUNNEL, service-loopback-group ID not set.
Tunnel source unknown, destination 3.3.3.3
Tunnel bandwidth 64 (kbps)
Tunnel protocol/transport CR_LSP
Output queue : (Urgent queuing : Size/Length/Discards) 0/100/0
Output queue : (Protocol queuing : Size/Length/Discards) 0/500/0
Output queue : (FIFO queuing : Size/Length/Discards) 0/75/0
Last clearing of counters: Never
  Last 300 seconds input: 0 bytes/sec, 0 packets/sec
  Last 300 seconds output: 0 bytes/sec, 0 packets/sec
  0 packets input, 0 bytes
  0 input error
  20 packets output, 1740 bytes
  0 output error

```

3.6 配置文件

- Router A 配置:

```

#
router id 1.1.1.1
#
mpls lsr-id 1.1.1.1
#
mpls
mpls te
mpls te timer fast-reroute 1
mpls rsvp-te
mpls te cspf
#
explicit-path RouterB
next hop 1.0.0.2
next hop 3.3.3.3
#
explicit-path primary
next hop 3.0.0.2
next hop 3.3.3.3
#
interface LoopBack0
ip address 1.1.1.1 255.255.255.255
#
interface Ethernet0/1
ip address 192.168.1.1 255.255.255.0
#

```

```

interface Ethernet0/2
 ip address 3.0.0.1 255.255.255.0
 mpls
 mpls te
 mpls te max-link-bandwidth 50000
 mpls te max-reservable-bandwidth 50000
 mpls te fast-reroute RouterB-tunnel Tunnel1
 mpls rsvp-te
#
interface Ethernet0/3
 ip address 1.0.0.1 255.255.255.0
 mpls
 mpls te
 mpls te max-link-bandwidth 50000
 mpls te max-reservable-bandwidth 50000
 mpls rsvp-te
#
interface Tunnel0
 ip address 10.0.0.1 255.255.255.252
 tunnel-protocol mpls te
 destination 3.3.3.3
 mpls te record-route label
 mpls te bandwidth ct0 30000
 mpls te path explicit-path primary preference 1
 mpls te fast-reroute
 mpls te commit
#
interface Tunnel1
 ip address 20.0.0.1 255.255.255.252
 tunnel-protocol mpls te
 destination 3.3.3.3
 mpls te tunnel-id 20
 mpls te record-route label
 mpls te bandwidth ct0 30000
 mpls te path explicit-path bypass preference 2
 mpls te backup bandwidth 20000
 mpls te commit
#
ospf 1
 opaque-capability enable
 area 0.0.0.0
 network 1.1.1.1 0.0.0.0
 network 1.0.0.0 0.0.0.255
 network 3.0.0.0 0.0.0.255
#
 ip route-static 192.168.2.0 255.0.0.0 Tunnel0 preference 1
 ip route-static 192.168.2.0 255.0.0.0 tunnel1 preference 2

```

- Router B 配置:

```

#
router id 2.2.2.2
#
mpls lsr-id 2.2.2.2
#
mpls
mpls te
mpls rsvp-te
mpls te cspf
#
interface LoopBack0
ip address 2.2.2.2 255.255.255.255
#
interface Ethernet0/1
port link-mode route
ip address 1.0.0.2 255.255.255.0
mpls
mpls te
mpls rsvp-te
#
interface Ethernet0/2
port link-mode route
ip address 2.0.0.1 255.255.255.0
mpls
mpls te
mpls rsvp-te
#
ospf 1
opaque-capability enable
area 0.0.0.0
network 2.2.2.2 0.0.0.0
network 2.0.0.0 0.0.0.255
mpls-te enable

```

- **Router C 配置:**

```

#
router id 3.3.3.3
#
mpls lsr-id 3.3.3.3
#
mpls
mpls te
mpls te timer fast-reroute 1
mpls te cspf
#
explicit-path RouterB
next hop 2.0.0.1
next hop 1.0.0.1
next hop 1.1.1.1

```

```

#
explicit-path primary
  next hop 3.0.0.1
  next hop 1.1.1.1
#
interface LoopBack0
  address 3.3.3.3 255.255.255.255
#
interface Ethernet0/1
  port link-mode route
  ip address 192.168.2.1 255.255.255.0
#
interface Ethernet0/2
  ip address 3.0.0.2 255.255.255.0
  mpls
  mpls te
  mpls te max-link-bandwidth 50000
  mpls te max-reservable-bandwidth 50000
  mpls te fast-reroute bypass-tunnel Tunnel1
  mpls rsvp-te
#
interface Ethernet0/3
  port link-mode route
  ip address 2.0.0.2 255.255.255.0
  mpls
  mpls te
  mpls te max-link-bandwidth 50000
  mpls te max-reservable-bandwidth 50000
  mpls rsvp-te
#
interface Tunnel0
  ip address 10.0.0.2 255.255.255.252
  tunnel-protocol mpls te
  destination 1.1.1.1
  mpls te tunnel-id 10
  mpls te record-route label
  mpls te bandwidth ct0 30000
  mpls te path explicit-path primary preference 1
  mpls te fast-reroute
  mpls te commit
#
interface Tunnel1
  ip address 20.0.0.2 255.255.255.252
  tunnel-protocol mpls te
  destination 1.1.1.1
  mpls te tunnel-id 20
  mpls te record-route label
  mpls te bandwidth ct0 30000

```



```
mpls te path explicit-path bypass preference 2
mpls te backup bandwidth 20000
mpls te commit
#
ospf 1
opaque-capability enable
area 0.0.0.0
network 3.3.3.3 0.0.0.0
network 3.0.0.0 0.0.0.255
network 2.0.0.0 0.0.0.255
mpls-te enable
#
ip route-static 192.168.1.0 255.255.255.0 Tunnel0 preference 1
ip route-static 192.168.1.0 255.255.255.0 Tunnel1 preference 2
```

4 相关资料

- H3C MSR 系列路由器 命令参考(V5)-R2311
- H3C MSR 系列路由器 配置指导(V5)-R2311