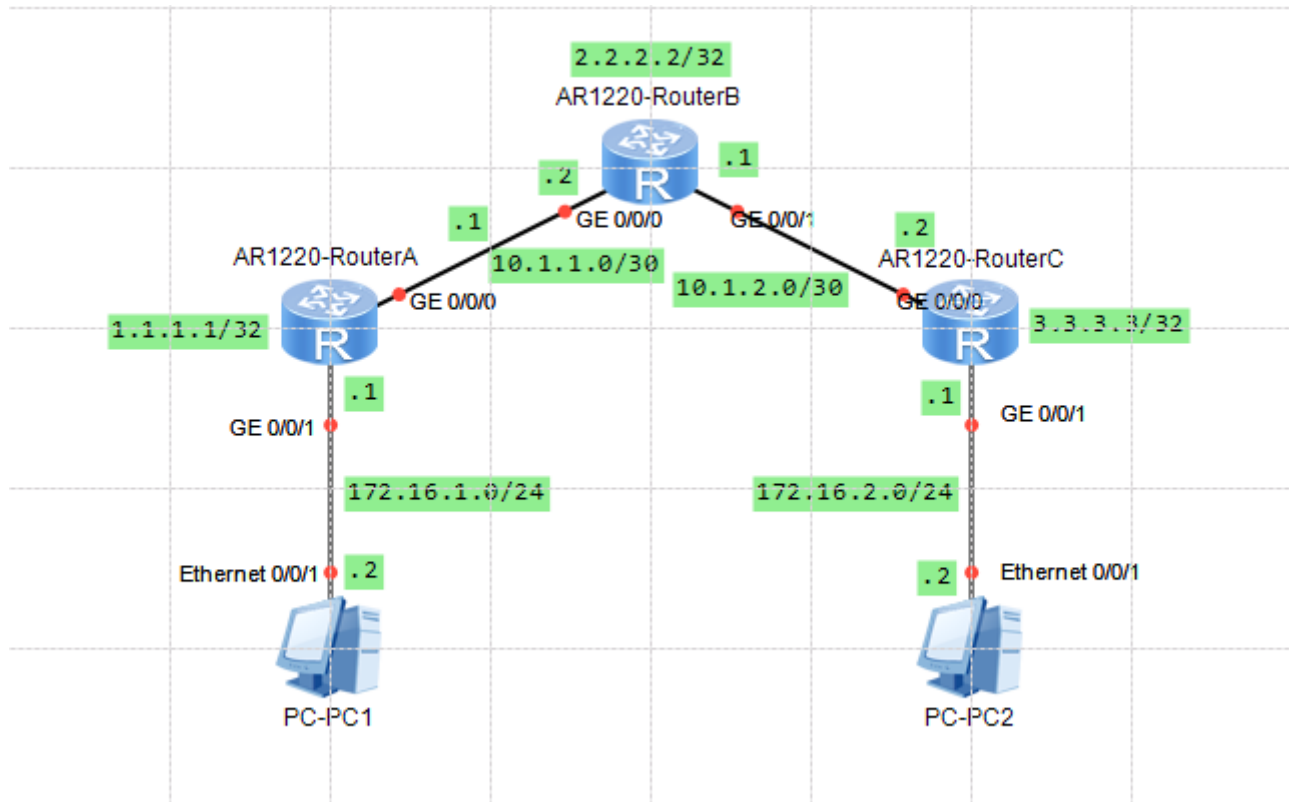


Ejercicio MPLS - LDP y OSPF

Se prepara el sistema, creando las conexiones necesarias. Posteriormente se configura OSPF. Por último se configura MPLS.

Topología



RA y RB tienen una conexión point-to-point

RB y RC tienen una conexión point-to-point

Configuración

Router A

```
<Huawei>system-view
[Huawei]sysname RouterA

[RouterA]interface LoopBack 0
[RouterA-LoopBack0]ip address 1.1.1.1 32

[RouterA-LoopBack0]interface GigabitEthernet 0/0/0
[RouterA-GigabitEthernet0/0/0]ip address 10.1.1.1 30

[RouterA-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1
[RouterA-GigabitEthernet0/0/1]ip address 172.16.1.1 24
```

```
[RouterA]ospf 100
[RouterA-ospf-100]area 0
[RouterA-ospf-100-area-0.0.0.0]network 1.1.1.1 0.0.0.0
[RouterA-ospf-100-area-0.0.0.0]network 10.1.1.0 0.0.0.3
[RouterA-ospf-100-area-0.0.0.0]network 172.16.1.0 0.0.0.255

[RouterA]mpls lsr-id 1.1.1.1
[RouterA]mpls
[RouterA-mpls]label advertise non-null
[RouterA-mpls]lsp-trigger ip-prefix LAN
[RouterA-mpls]mpls ldp

[RouterA]ip ip-prefix LAN index 10 permit 172.16.1.0 24
[RouterA]ip ip-prefix LAN index 20 permit 172.16.2.0 24

[RouterA]interface GigabitEthernet 0/0/0
[RouterA-GigabitEthernet0/0/0]mpls
[RouterA-GigabitEthernet0/0/0]mpls ldp

<RouterA>save
```

Router B

```
<Huawei>system-view
[Huawei]sysname RouterB

[RouterB]interface LoopBack 0
[RouterB-LoopBack0]ip address 2.2.2.2 32

[RouterB-LoopBack0]interface GigabitEthernet 0/0/0
[RouterB-GigabitEthernet0/0/0]ip address 10.1.1.2 30

[RouterB-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1
[RouterB-GigabitEthernet0/0/1]ip address 10.1.2.1 30

[RouterB]ospf 100
[RouterB-ospf-100]area 0
[RouterB-ospf-100-area-0.0.0.0]network 2.2.2.2 0.0.0.0
[RouterB-ospf-100-area-0.0.0.0]network 10.1.1.0 0.0.0.3
[RouterB-ospf-100-area-0.0.0.0]network 10.1.2.0 0.0.0.3

[RouterB]mpls lsr-id 2.2.2.2
[RouterB]mpls
[RouterB-mpls]label advertise non-null
[RouterB-mpls]lsp-trigger ip-prefix LAN
[RouterB-mpls]mpls ldp

[RouterB]ip ip-prefix LAN index 10 permit 172.16.1.0 24
[RouterB]ip ip-prefix LAN index 20 permit 172.16.2.0 24

[RouterB]interface GigabitEthernet 0/0/0
```

```
[RouterB-GigabitEthernet0/0/0]mpls
[RouterB-GigabitEthernet0/0/0]mpls ldp

[RouterB-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1
[RouterB-GigabitEthernet0/0/1]mpls
[RouterB-GigabitEthernet0/0/1]mpls ldp

<RouterB>save
```

Router C

```
<Huawei>system-view
[Huawei]sysname RouterC

[RouterC]interface LoopBack 0
[RouterC-LoopBack0]ip address 3.3.3.3 32

[RouterC-LoopBack0]interface GigabitEthernet 0/0/0
[RouterC-GigabitEthernet0/0/0]ip address 10.1.2.2 30

[RouterC-GigabitEthernet0/0/0]interface GigabitEthernet 0/0/1
[RouterC-GigabitEthernet0/0/1]ip address 172.16.2.1 24

[RouterC]ospf 100
[RouterC-ospf-100]area 0
[RouterC-ospf-100-area-0.0.0.0]network 3.3.3.3 0.0.0.0
[RouterC-ospf-100-area-0.0.0.0]network 10.1.2.0 0.0.0.3
[RouterC-ospf-100-area-0.0.0.0]network 172.16.2.0 0.0.0.255

[RouterC]mpls lsr-id 3.3.3.3
[RouterC]mpls
[RouterC-mpls]label advertise non-null
[RouterC-mpls]lsp-trigger ip-prefix LAN
[RouterC-mpls]mpls ldp

[RouterC]ip ip-prefix LAN index 10 permit 172.16.1.0 24
[RouterC]ip ip-prefix LAN index 20 permit 172.16.2.0 24

[RouterC]interface GigabitEthernet 0/0/0
[RouterC-GigabitEthernet0/0/0]mpls
[RouterC-GigabitEthernet0/0/0]mpls ldp

<RouterC>save
```

Tablas de enrutamiento

Router A

```
<RouterA>display ip routing-table
Route Flags: R - relay, D - download to fib
```

```
-----
---
```

```
Routing Tables: Public
```

```
Destinations : 11
```

```
Routes : 11
```

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
1.1.1.1/32	Direct	0	0	D	127.0.0.1	LoopBack0
2.2.2.2/32	OSPF	10	1	D	10.1.1.2	
GigabitEthernet0/0/0						
3.3.3.3/32	OSPF	10	2	D	10.1.1.2	
GigabitEthernet0/0/0						
10.1.1.0/30	Direct	0	0	D	10.1.1.1	
GigabitEthernet0/0/0						
10.1.1.1/32	Direct	0	0	D	127.0.0.1	
GigabitEthernet0/0/0						
10.1.1.3/32	Direct	0	0	D	127.0.0.1	
GigabitEthernet0/0/0						
10.1.2.0/30	OSPF	10	2	D	10.1.1.2	
GigabitEthernet0/0/0						
127.0.0.0/8	Direct	0	0	D	127.0.0.1	
InLoopBack0						
127.0.0.1/32	Direct	0	0	D	127.0.0.1	
InLoopBack0						
127.255.255.255/32	Direct	0	0	D	127.0.0.1	
InLoopBack0						
255.255.255.255/32	Direct	0	0	D	127.0.0.1	
InLoopBack0						

Router B

```
<RouterB>display ip routing-table
Route Flags: R - relay, D - download to fib
```

```
-----
---
```

```
Routing Tables: Public
```

```
Destinations : 13
```

```
Routes : 13
```

Destination/Mask	Proto	Pre	Cost	Flags	NextHop	Interface
1.1.1.1/32	OSPF	10	1	D	10.1.1.1	LoopBack0
GigabitEthernet0/0/0						
2.2.2.2/32	Direct	0	0	D	127.0.0.1	
3.3.3.3/32	OSPF	10	1	D	10.1.2.2	
GigabitEthernet0/0/1						
10.1.1.0/30	Direct	0	0	D	10.1.1.2	
GigabitEthernet0/0/0						
10.1.1.2/32	Direct	0	0	D	127.0.0.1	

```

GigabitEthernet0/0/0
    10.1.1.3/32 Direct 0 0 D 127.0.0.1
GigabitEthernet0/0/0
    10.1.2.0/30 Direct 0 0 D 10.1.2.1
GigabitEthernet0/0/1
    10.1.2.1/32 Direct 0 0 D 127.0.0.1
GigabitEthernet0/0/1
    10.1.2.3/32 Direct 0 0 D 127.0.0.1
GigabitEthernet0/0/1
    127.0.0.0/8 Direct 0 0 D 127.0.0.1
InLoopBack0
    127.0.0.1/32 Direct 0 0 D 127.0.0.1
InLoopBack0
127.255.255.255/32 Direct 0 0 D 127.0.0.1
InLoopBack0
255.255.255.255/32 Direct 0 0 D 127.0.0.1
InLoopBack0

```

Router C

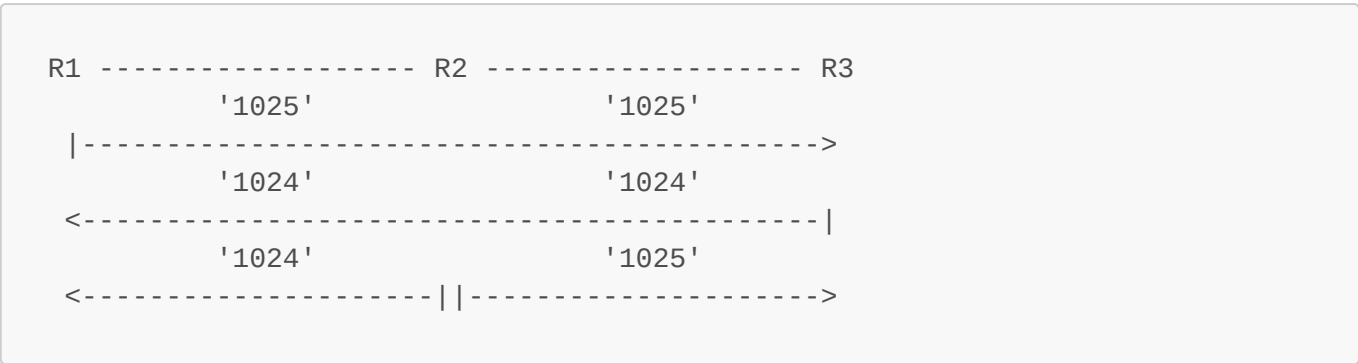
```

<RouterC>display ip routing-table
Route Flags: R - relay, D - download to fib
-----
---
Routing Tables: Public
    Destinations : 11          Routes : 11

Destination/Mask    Proto    Pre  Cost           Flags NextHop          Interface
-----
    1.1.1.1/32   OSPF     10    2             D   10.1.2.1
GigabitEthernet0/0/0
    2.2.2.2/32   OSPF     10    1             D   10.1.2.1
GigabitEthernet0/0/0
    3.3.3.3/32   Direct    0     0             D   127.0.0.1      LoopBack0
    10.1.1.0/30   OSPF     10    2             D   10.1.2.1
GigabitEthernet0/0/0
    10.1.2.0/30   Direct    0     0             D   10.1.2.2
GigabitEthernet0/0/0
    10.1.2.2/32   Direct    0     0             D   127.0.0.1
GigabitEthernet0/0/0
    10.1.2.3/32   Direct    0     0             D   127.0.0.1
GigabitEthernet0/0/0
    127.0.0.0/8   Direct    0     0             D   127.0.0.1
InLoopBack0
    127.0.0.1/32   Direct    0     0             D   127.0.0.1
InLoopBack0
127.255.255.255/32 Direct    0     0             D   127.0.0.1
InLoopBack0
255.255.255.255/32 Direct    0     0             D   127.0.0.1
InLoopBack0

```

LSPs generados (4)



Router A

```
<RouterA>display mpls lsp
-----
LSP Information: LDP LSP
-----
FEC          In/Out Label  In/Out IF          Vrf Name
172.16.1.0/24 1024/NULL      -/-
172.16.2.0/24 NULL/1025      -/GE0/0/0
172.16.2.0/24 1025/1025     -/GE0/0/0
```

Router B

```
<RouterB>display mpls lsp
-----
LSP Information: LDP LSP
-----
FEC          In/Out Label  In/Out IF          Vrf Name
172.16.1.0/24 NULL/1024     -/GE0/0/0
172.16.1.0/24 1024/1024     -/GE0/0/0
172.16.2.0/24 NULL/1025     -/GE0/0/1
172.16.2.0/24 1025/1025     -/GE0/0/1
```

Router C

```
<RouterC>display mpls lsp
-----
LSP Information: LDP LSP
-----
```

```

-----
FEC                               In/Out Label  In/Out IF                Vrf Name
172.16.1.0/24                     NULL/1024    -/GE0/0/0
172.16.1.0/24                     1024/1024    -/GE0/0/0
172.16.2.0/24                     1025/NULL    -/-

```

Comprobación del triggering

Ping interLAN

```

<RouterA>ping -a 172.16.1.1 172.16.2.1
PING 172.16.2.1: 56 data bytes, press CTRL_C to break
  Reply from 172.16.2.1: bytes=56 Sequence=1 ttl=254 time=290 ms
  Reply from 172.16.2.1: bytes=56 Sequence=2 ttl=254 time=110 ms
  Reply from 172.16.2.1: bytes=56 Sequence=3 ttl=254 time=140 ms
  Reply from 172.16.2.1: bytes=56 Sequence=4 ttl=254 time=60 ms
  Reply from 172.16.2.1: bytes=56 Sequence=5 ttl=254 time=70 ms

--- 172.16.2.1 ping statistics ---
  5 packet(s) transmitted
  5 packet(s) received
  0.00% packet loss
  round-trip min/avg/max = 60/134/290 ms

```

Paquetes capturados con Wireshark en Router B

AB

BC

Los routers utilizan MPLS para transportar los Paquetes

Ping interLOOPBACKS

```
<RouterA>ping -a 1.1.1.1 3.3.3.3
PING 3.3.3.3: 56 data bytes, press CTRL_C to break
Reply from 3.3.3.3: bytes=56 Sequence=1 ttl=254 time=100 ms
Reply from 3.3.3.3: bytes=56 Sequence=2 ttl=254 time=80 ms
Reply from 3.3.3.3: bytes=56 Sequence=3 ttl=254 time=60 ms
Reply from 3.3.3.3: bytes=56 Sequence=4 ttl=254 time=60 ms
Reply from 3.3.3.3: bytes=56 Sequence=5 ttl=254 time=70 ms

--- 3.3.3.3 ping statistics ---
5 packet(s) transmitted
5 packet(s) received
0.00% packet loss
round-trip min/avg/max = 60/74/100 ms
```

Paquetes capturados con Wireshark en Router B

Filter: icmp Expression... Clear Apply							Filter: icmp Expression... Clear Apply						
No.	Time	Source	Destination	Protocol	Info		No.	Time	Source	Destination	Protocol	Info	
64	69.997000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x1)		55	59.218000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x1)	
65	70.044000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x1)		56	59.233000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x1)	
66	70.465000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x2)		57	59.701000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x2)	
67	70.528000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x2)		58	59.717000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x2)	
71	70.980000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x3)		59	60.185000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x3)	
72	71.011000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x3)		60	60.216000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x3)	
73	71.479000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x4)		61	60.700000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x4)	
74	71.510000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x4)		62	60.715000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x4)	
75	71.994000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x5)		63	61.199000	1.1.1.1	3.3.3.3	ICMP	Echo (ping) request (id=0xd2ab, seq=0x5)	
76	72.025000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x5)		64	61.230000	3.3.3.3	1.1.1.1	ICMP	Echo (ping) reply (id=0xd2ab, seq=0x5)	

AB

BC

<p>64 69.997000 1.1.1.1 3.3.3.3 ICMP Echo (ping) request (id=0xd2ab, seq=0x1, ttl=255)</p> <p>Frame 64: 98 bytes on wire (784 bits), 98 bytes captured (784 bits)</p> <p>Ethernet II, Src: HuaweiTe_c9:4b:7b (00:e0:fc:c9:4b:7b), Dst: HuaweiTe_37:4d:de (00:e0:fc:37:4d:de)</p> <p>Internet Protocol, Src: 1.1.1.1 (1.1.1.1), Dst: 3.3.3.3 (3.3.3.3)</p> <p>Internet Control Message Protocol</p>	<p>55 59.218000 1.1.1.1 3.3.3.3 ICMP Echo (ping) request (id=0xd2ab, seq=0x1, ttl=254)</p> <p>Frame 55: 98 bytes on wire (784 bits), 98 bytes captured (784 bits)</p> <p>Ethernet II, Src: HuaweiTe_37:4d:df (00:e0:fc:37:4d:df), Dst: HuaweiTe_c5:2a:26 (00:e0:fc:c5:2a:26)</p> <p>Internet Protocol, Src: 1.1.1.1 (1.1.1.1), Dst: 3.3.3.3 (3.3.3.3)</p> <p>Internet Control Message Protocol</p>
<p>65 70.044000 3.3.3.3 1.1.1.1 ICMP Echo (ping) reply (id=0xd2ab, seq=0x1, ttl=254)</p> <p>Frame 65: 98 bytes on wire (784 bits), 98 bytes captured (784 bits)</p> <p>Ethernet II, Src: HuaweiTe_37:4d:de (00:e0:fc:37:4d:de), Dst: HuaweiTe_c9:4b:7b (00:e0:fc:c9:4b:7b)</p> <p>Internet Protocol, Src: 3.3.3.3 (3.3.3.3), Dst: 1.1.1.1 (1.1.1.1)</p> <p>Internet Control Message Protocol</p>	<p>56 59.233000 3.3.3.3 1.1.1.1 ICMP Echo (ping) reply (id=0xd2ab, seq=0x1, ttl=255)</p> <p>Frame 56: 98 bytes on wire (784 bits), 98 bytes captured (784 bits)</p> <p>Ethernet II, Src: HuaweiTe_c5:2a:26 (00:e0:fc:c5:2a:26), Dst: HuaweiTe_37:4d:df (00:e0:fc:37:4d:df)</p> <p>Internet Protocol, Src: 3.3.3.3 (3.3.3.3), Dst: 1.1.1.1 (1.1.1.1)</p> <p>Internet Control Message Protocol</p>

Los routers utilizan el protocolo IP, no MPLS, para transportar paquetes.

Ping Router A a LAN 2

```
<RouterA>ping 172.16.2.1
PING 172.16.2.1: 56 data bytes, press CTRL_C to break
Reply from 172.16.2.1: bytes=56 Sequence=1 ttl=254 time=70 ms
Reply from 172.16.2.1: bytes=56 Sequence=2 ttl=254 time=50 ms
Reply from 172.16.2.1: bytes=56 Sequence=3 ttl=254 time=70 ms
Reply from 172.16.2.1: bytes=56 Sequence=4 ttl=254 time=60 ms
Reply from 172.16.2.1: bytes=56 Sequence=5 ttl=254 time=50 ms

--- 172.16.2.1 ping statistics ---
5 packet(s) transmitted
5 packet(s) received
0.00% packet loss
round-trip min/avg/max = 50/60/70 ms
```


Paquetes capturados con Wireshark en Router B

Filter: icmp Expression... Clear Apply							Filter: icmp Expression... Clear Apply						
No.	Time	Source	Destination	Protocol	Info		No.	Time	Source	Destination	Protocol	Info	
67	74.834000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=256/1, ttl=255)		62	69.873000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=256/1, ttl=255)	
68	74.865000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=256/1, ttl=254)		63	69.904000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=256/1, ttl=254)	
69	75.317000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=257/1, ttl=255)		64	70.372000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=257/1, ttl=255)	
70	75.349000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=257/1, ttl=254)		65	70.388000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=257/1, ttl=254)	
71	75.817000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=258/1, ttl=255)		66	70.871000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=258/1, ttl=255)	
72	75.879000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=258/1, ttl=254)		69	70.902000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=258/1, ttl=254)	
73	76.331000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=259/1, ttl=255)		71	71.370000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=259/1, ttl=255)	
74	76.363000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=259/1, ttl=254)		72	71.386000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=259/1, ttl=254)	
76	76.815000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=260/1, ttl=255)		73	71.854000	10.1.1.1	172.16.2.1	ICMP	Echo (ping) request (id=0xd4ab, seq=260/1, ttl=255)	
77	76.846000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=260/1, ttl=254)		74	71.885000	172.16.2.1	10.1.1.1	ICMP	Echo (ping) reply (id=0xd4ab, seq=260/1, ttl=254)	

AB

BC

67 74.834000 10.1.1.1 172.16.2.1 ICMP Echo (ping) request (id=0xd4ab, seq=256/1, ttl=255) Frame 67: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) Ethernet II, Src: HuaweiTe_c9:4b:7b (00:e0:fc:c9:4b:7b), Dst: HuaweiTe_37:4d:de (00:e0:fc:37:4d:de) MultiProtocol Label Switching Header, Label: 1025, Exp: 0, S: 1, TTL: 255 MPLS Label: 1025 MPLS Experimental Bits: 0 MPLS Bottom of Label Stack: 1 MPLS TTL: 255 Internet Protocol, Src: 10.1.1.1 (10.1.1.1), Dst: 172.16.2.1 (172.16.2.1) Internet Control Message Protocol		62 69.873000 10.1.1.1 172.16.2.1 ICMP Echo (ping) request (id=0xd4ab, seq=256/1, ttl=255) Frame 62: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) Ethernet II, Src: HuaweiTe_37:4d:df (00:e0:fc:37:4d:df), Dst: HuaweiTe_c5:2a:26 (00:e0:fc:c5:2a:26) MultiProtocol Label Switching Header, Label: 1025, Exp: 0, S: 1, TTL: 254 MPLS Label: 1025 MPLS Experimental Bits: 0 MPLS Bottom of Label Stack: 1 MPLS TTL: 254 Internet Protocol, Src: 10.1.1.1 (10.1.1.1), Dst: 172.16.2.1 (172.16.2.1) Internet Control Message Protocol	
68 74.865000 172.16.2.1 10.1.1.1 ICMP Echo (ping) reply (id=0xd4ab, seq=256/1, ttl=254) Frame 68: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) Ethernet II, Src: HuaweiTe_37:4d:de (00:e0:fc:c9:4b:7b), Dst: HuaweiTe_c9:4b:7b (00:e0:fc:c9:4b:7b) Internet Protocol, Src: 172.16.2.1 (172.16.2.1), Dst: 10.1.1.1 (10.1.1.1) Internet Control Message Protocol		63 69.904000 172.16.2.1 10.1.1.1 ICMP Echo (ping) reply (id=0xd4ab, seq=256/1, ttl=255) Frame 63: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) Ethernet II, Src: HuaweiTe_c5:2a:26 (00:e0:fc:c5:2a:26), Dst: HuaweiTe_37:4d:df (00:e0:fc:37:4d:df) Internet Protocol, Src: 172.16.2.1 (172.16.2.1), Dst: 10.1.1.1 (10.1.1.1) Internet Control Message Protocol	

Los routers utilizan MPLS solo a la ida. A la vuelta solo utilizan IP.

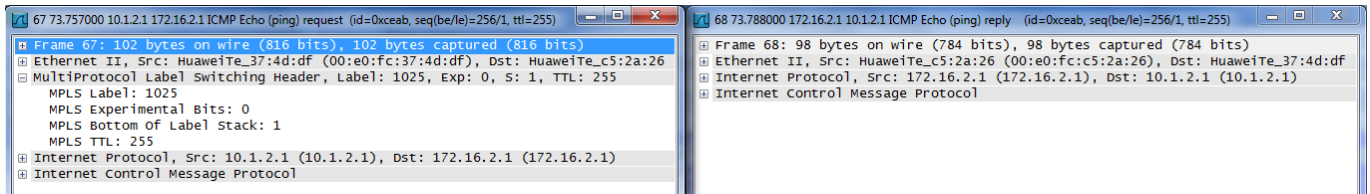
Ping Router B a LAN 3

```
<RouterB>ping 172.16.2.1
PING 172.16.2.1: 56 data bytes, press CTRL_C to break
Reply from 172.16.2.1: bytes=56 Sequence=1 ttl=255 time=60 ms
Reply from 172.16.2.1: bytes=56 Sequence=2 ttl=255 time=40 ms
Reply from 172.16.2.1: bytes=56 Sequence=3 ttl=255 time=40 ms
Reply from 172.16.2.1: bytes=56 Sequence=4 ttl=255 time=30 ms
Reply from 172.16.2.1: bytes=56 Sequence=5 ttl=255 time=30 ms

--- 172.16.2.1 ping statistics ---
5 packet(s) transmitted
5 packet(s) received
0.00% packet loss
round-trip min/avg/max = 30/40/60 ms
```

Paquetes capturados con Wireshark en Router B

Filter: icmp Expression... Clear Apply					
No.	Time	Source	Destination	Protocol	Info
67	73.757000	10.1.2.1	172.16.2.1	ICMP	Echo (ping) request (id=0xceab, seq=256/1, ttl=255)
68	73.788000	172.16.2.1	10.1.2.1	ICMP	Echo (ping) reply (id=0xceab, seq=256/1, ttl=255)
69	74.256000	10.1.2.1	172.16.2.1	ICMP	Echo (ping) request (id=0xceab, seq=512/2, ttl=255)
70	74.272000	172.16.2.1	10.1.2.1	ICMP	Echo (ping) reply (id=0xceab, seq=512/2, ttl=255)
73	74.771000	10.1.2.1	172.16.2.1	ICMP	Echo (ping) request (id=0xceab, seq=768/3, ttl=255)
74	74.787000	172.16.2.1	10.1.2.1	ICMP	Echo (ping) reply (id=0xceab, seq=768/3, ttl=255)
77	75.286000	10.1.2.1	172.16.2.1	ICMP	Echo (ping) request (id=0xceab, seq=1024/4, ttl=255)
78	75.302000	172.16.2.1	10.1.2.1	ICMP	Echo (ping) reply (id=0xceab, seq=1024/4, ttl=255)
79	75.801000	10.1.2.1	172.16.2.1	ICMP	Echo (ping) request (id=0xceab, seq=1280/5, ttl=255)
80	75.816000	172.16.2.1	10.1.2.1	ICMP	Echo (ping) reply (id=0xceab, seq=1280/5, ttl=255)



Los routers solo utilizan MPLS a la ida. A la vuelta utilizan IP.

Comprobación de PHP

NON-NULL

Es como estuvimos trabajando hasta el momento.

LSPs generados (4)

```

R1 ----- R2 ----- R3
      '1025'                '1025'
|----->
      '1024'                '1024'
<-----|
      '1024'                '1025'
<-----||----->
  
```

Router A

```

<RouterA>display mpls lsp
-----
LSP Information: LDP LSP
-----
FEC                In/Out Label  In/Out IF          Vrf Name
172.16.1.0/24      1024/NULL          -/-
172.16.2.0/24      NULL/1025          -/GE0/0/0
172.16.2.0/24      1025/1025          -/GE0/0/0
  
```

Router B

```

<RouterB>display mpls lsp
-----
LSP Information: LDP LSP
-----
FEC                In/Out Label  In/Out IF          Vrf Name
172.16.1.0/24      NULL/1024      -/GE0/0/0
  
```

172.16.1.0/24	1024/1024	-/GE0/0/0
172.16.2.0/24	NULL/1025	-/GE0/0/1
172.16.2.0/24	1025/1025	-/GE0/0/1

Router C

```
<RouterC>display mpls lsp
-----
----
                        LSP Information: LDP LSP
-----
----
FEC                      In/Out Label  In/Out IF                Vrf Name
172.16.1.0/24            NULL/1024    -/GE0/0/0
172.16.1.0/24            1024/1024    -/GE0/0/0
172.16.2.0/24            1025/NULL    -/-
```

IMPLICIT-NULL

Lo que hace es colocar como etiqueta final '3' lo que permite al E-LSR no tener que hacer búsqueda en la tabla MPLS pero aun así debe quitar la etiqueta. El problema es que se pierden los bits de EXP que se usan para calidad de servicio. Es el que se utiliza por defecto en estos routers HUAWEI. Para utilizarlo debemos reconfigurar los routers y reiniciarlos para que el cambio surta efecto.

Configuración de los routers

```
[RouterX]mpls
[RouterX-mpls]label advertise implicit-null

<RouterX>save
<RouterX>reboot
```

LSPs generados(4)

```
R1 ----- R2 ----- R3
      '1026'                '3'
|----->
      '3'                '1025'
<-----|
      '3'                '3'
<-----|----->
```

Router A

```
<RouterA>display mpls lsp
```

```
-----  
----  
                        LSP Information: LDP LSP  
-----  
----  
FEC                      In/Out Label  In/Out IF                      Vrf Name  
172.16.2.0/24            NULL/1026    -/GE0/0/0  
172.16.2.0/24            1025/1026    -/GE0/0/0  
172.16.1.0/24            3/NULL       -/-
```

Router B

```
<RouterB>display mpls lsp
```

```
-----  
----  
                        LSP Information: LDP LSP  
-----  
----  
FEC                      In/Out Label  In/Out IF                      Vrf Name  
172.16.2.0/24            NULL/3       -/GE0/0/1  
172.16.1.0/24            NULL/3       -/GE0/0/0  
172.16.1.0/24            1025/3      -/GE0/0/0  
172.16.2.0/24            1026/3      -/GE0/0/1
```

Router C

```
<RouterC>display mpls lsp
```

```
-----  
----  
                        LSP Information: LDP LSP  
-----  
----  
FEC                      In/Out Label  In/Out IF                      Vrf Name  
172.16.1.0/24            NULL/1025    -/GE0/0/0  
172.16.1.0/24            1024/1025    -/GE0/0/0  
172.16.2.0/24            3/NULL       -/-
```

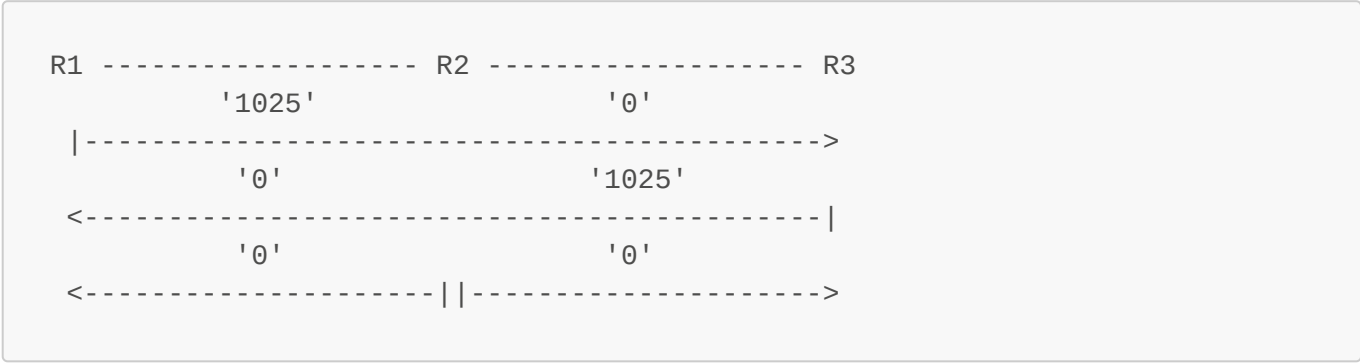
EXPLICIT-NULL

El router anterior al E-LSR poné la etiqueta en '0' para que éste no tenga que hacer un double lookup. La ventaja frente al IMPLICIT-NULL es que no se pierden los bits EXP para calidad de servicio. Para utilizarlo debemos reconfigurar los routers y reiniciarlos para que el cambio surta efecto.

```
[RouterX]mpls
[RouterX-mpls]label advertise explicit-null

<RouterX>save
<RouterX>reboot
```

LSPs generados(4)



Router A

```
<RouterA>display mpls lsp
-----
LSP Information: LDP LSP
-----
FEC                In/Out Label  In/Out IF          Vrf Name
172.16.1.0/24      0/NULL          -/-
172.16.2.0/24      NULL/1025        -/GE0/0/0
172.16.2.0/24      1024/1025        -/GE0/0/0
```

Router B

```
<RouterB>display mpls lsp
-----
LSP Information: LDP LSP
-----
FEC                In/Out Label  In/Out IF          Vrf Name
172.16.1.0/24      NULL/0         -/GE0/0/0
172.16.1.0/24      1024/0         -/GE0/0/0
172.16.2.0/24      NULL/0         -/GE0/0/1
172.16.2.0/24      1025/0         -/GE0/0/1
```

Router C

```
<RouterC>display mpls lsp
-----
----
                        LSP Information: LDP LSP
-----
----
FEC                In/Out Label  In/Out IF          Vrf Name
172.16.1.0/24      NULL/1024      -/GE0/0/0
172.16.1.0/24      1024/1024      -/GE0/0/0
172.16.2.0/24      0/NULL         -/-
```