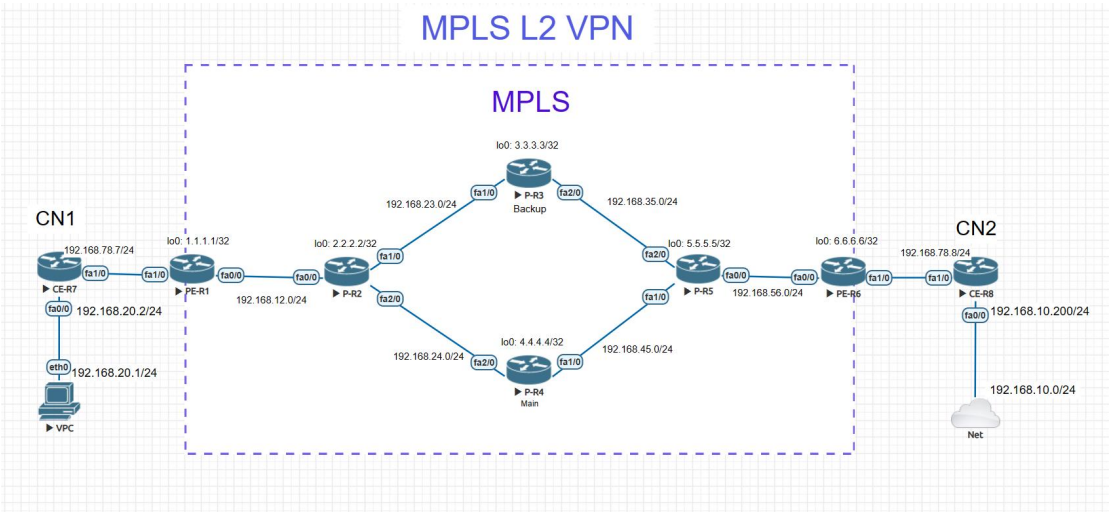
Mô hình:



Nội dung mô phỏng:

Ở nội dung mô phỏng này, ta sẽ thực hiện mô phỏng kết nối 2 chi nhánh với nhau bằng đường truyền MPLS-VPN. Cụ thể chính là đường MPLS-VPN Layer 2 để kết nối 2 chi nhánh này.

Giữa 2 chi nhánh sẽ được kết nối với nhau thông qua lớp mạng 192.168.78.0/24 qua router biên (CE - Customer Edge) ở mỗi phía chi nhánh.

Vùng MPLS sẽ được sẽ dụng giao thức định tuyến OSPF, đường truyền chính sẽ là được qua router lõi R4 (P-R4) còn đường truyền dự phòng là đường qua router lõi R3 (P-R3). Cũng chính vì sử dụng giao thức định tuyến OSPF nên nếu đường truyền chính gặp sự cố hay không hoạt động thì dự liệu sẽ được tự động chuyển qua đường dự phòng.

Ngoài ra, để dễ phân biệt thì các router trong vùng MPLS sẽ có dãy label khác nhau. Cụ thể như sau:

+ R1: 100 - 149

+ R2: 150 - 199

+ R3: 200 - 249

+ R4: 350 - 399

+ R5: 250 - 299

+ R6: 300 - 349

Kết quả

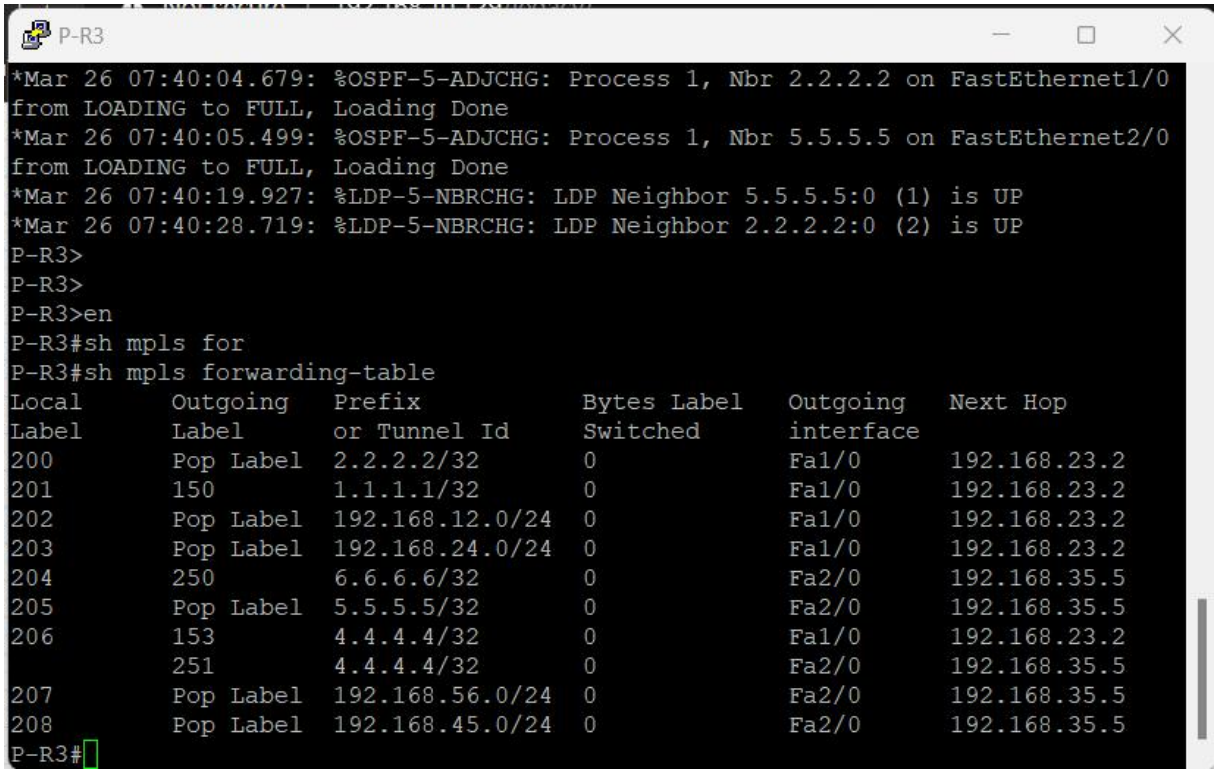
Bảng forwarding-table

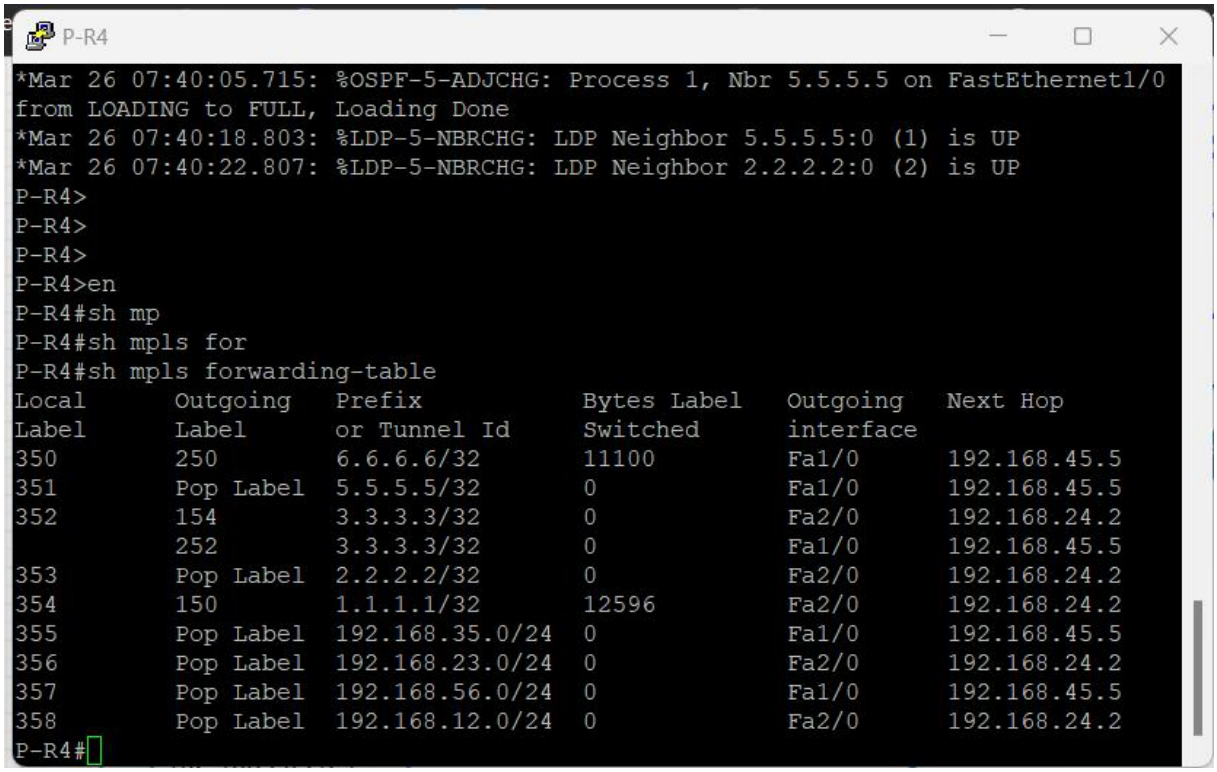
PE-R1

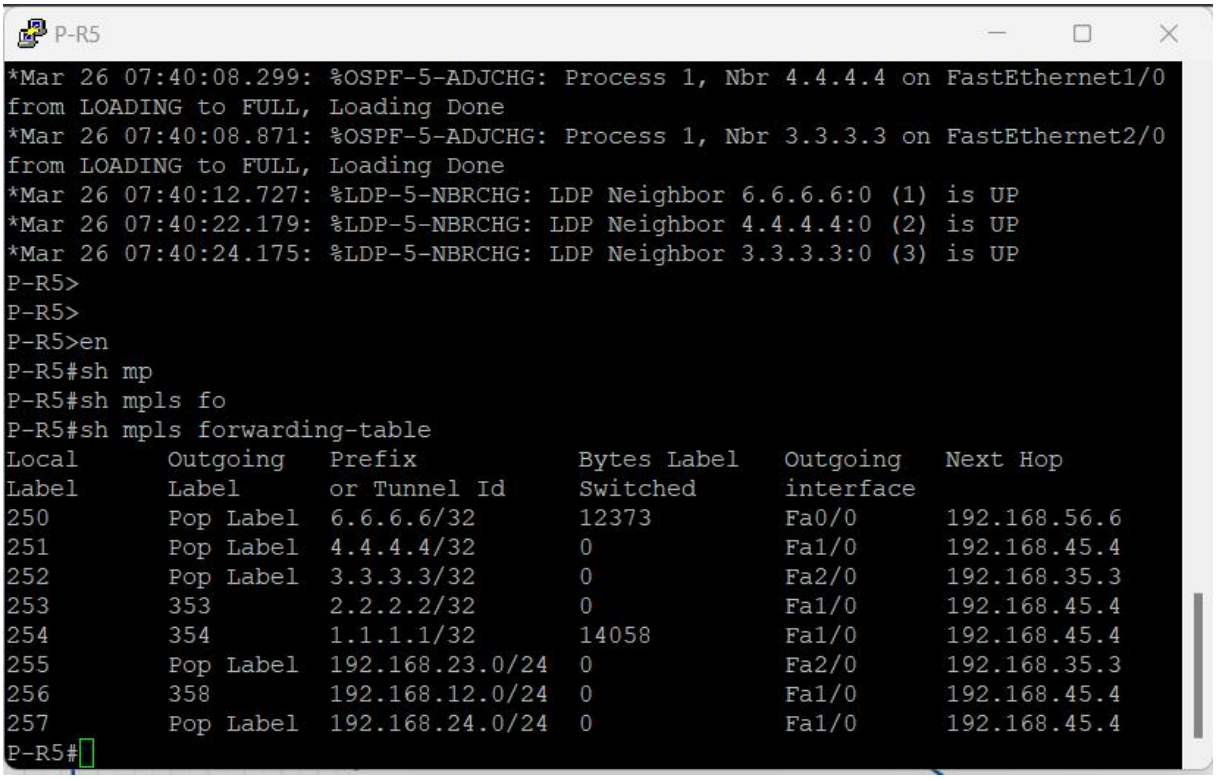
```
*Mar 26 07:40:06.319: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on FastEthernet0/0
from LOADING to FULL, Loading Done
*Mar 26 07:40:12.695: %LDP-5-NBRCHG: LDP Neighbor 2.2.2.2:0 (1) is UP
*Mar 26 07:40:22.503: %LDP-5-NBRCHG: LDP Neighbor 6.6.6.6:0 (2) is UP
PE-R1>
PE-R1>
PE-R1>
PE-R1>en
PE-R1#sh mpls for
PE-R1#sh mpls forwarding-table
Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
100        No Label   l2ckt(1)         5174          Fa1/0      point2point
101        Pop Label  2.2.2.2/32       0             Fa0/0      192.168.12.2
102        Pop Label  192.168.23.0/24  0             Fa0/0      192.168.12.2
103        Pop Label  192.168.24.0/24  0             Fa0/0      192.168.12.2
104        151        6.6.6.6/32       0             Fa0/0      192.168.12.2
105        152        5.5.5.5/32       0             Fa0/0      192.168.12.2
106        153        4.4.4.4/32       0             Fa0/0      192.168.12.2
107        154        3.3.3.3/32       0             Fa0/0      192.168.12.2
108        155        192.168.35.0/24  0             Fa0/0      192.168.12.2
109        156        192.168.56.0/24  0             Fa0/0      192.168.12.2
110        157        192.168.45.0/24  0             Fa0/0      192.168.12.2
PE-R1#
```

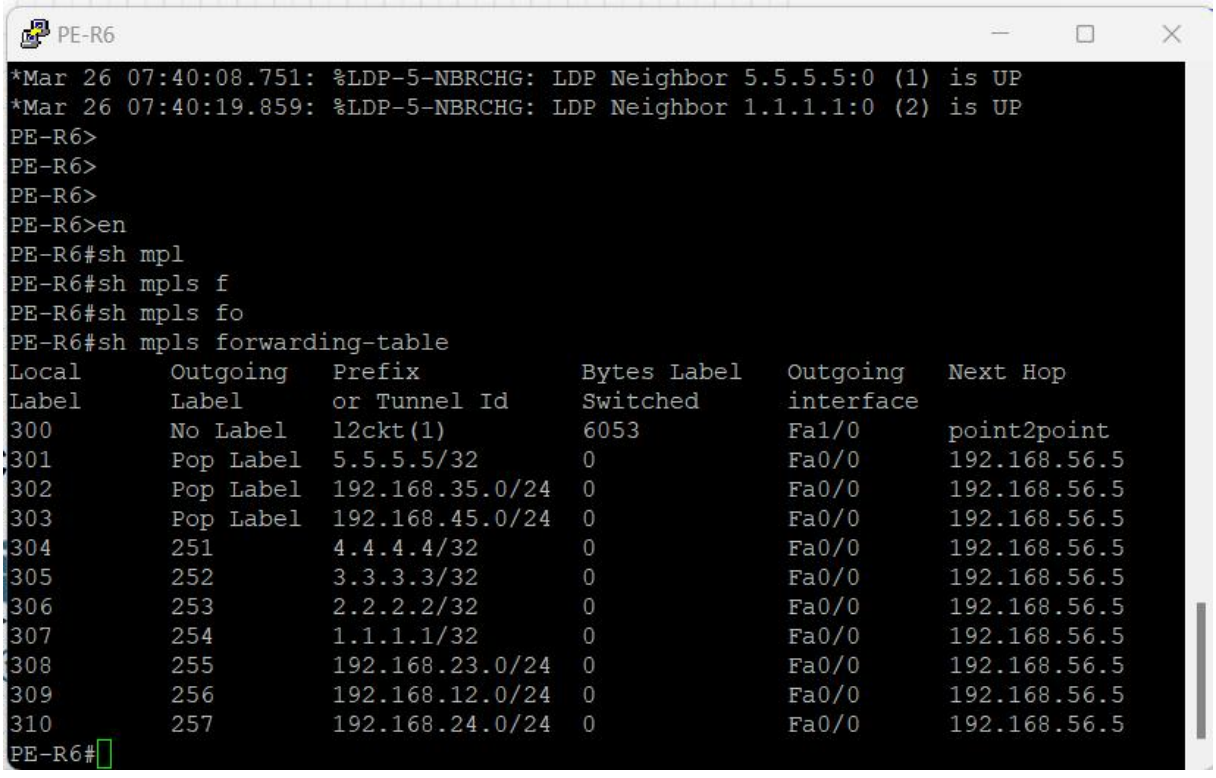
P-R2

```
et3/0, changed state to down
*Mar 26 07:40:05.703: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on FastEthernet0/0
from LOADING to FULL, Loading Done
*Mar 26 07:40:06.863: %OSPF-5-ADJCHG: Process 1, Nbr 3.3.3.3 on FastEthernet1/0
from LOADING to FULL, Loading Done
*Mar 26 07:40:06.967: %OSPF-5-ADJCHG: Process 1, Nbr 4.4.4.4 on FastEthernet2/0
from LOADING to FULL, Loading Done
*Mar 26 07:40:12.827: %LDP-5-NBRCHG: LDP Neighbor 1.1.1.1:0 (1) is UP
*Mar 26 07:40:25.067: %LDP-5-NBRCHG: LDP Neighbor 4.4.4.4:0 (2) is UP
*Mar 26 07:40:32.151: %LDP-5-NBRCHG: LDP Neighbor 3.3.3.3:0 (3) is UP
P-R2>en
P-R2#sh mpls for
P-R2#sh mpls forwarding-table
Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
150        Pop Label  1.1.1.1/32       11089         Fa0/0      192.168.12.1
151        350        6.6.6.6/32       10294         Fa2/0      192.168.24.4
152        351        5.5.5.5/32       0             Fa2/0      192.168.24.4
153        Pop Label  4.4.4.4/32       0             Fa2/0      192.168.24.4
154        Pop Label  3.3.3.3/32       0             Fa1/0      192.168.23.3
155        Pop Label  192.168.35.0/24  0             Fa1/0      192.168.23.3
156        357        192.168.56.0/24  0             Fa2/0      192.168.24.4
157        Pop Label  192.168.45.0/24  0             Fa2/0      192.168.24.4
P-R2#
```


P-R3
*Mar 26 07:40:04.679: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on FastEthernet1/0 from LOADING to FULL, Loading Done
*Mar 26 07:40:05.499: %OSPF-5-ADJCHG: Process 1, Nbr 5.5.5.5 on FastEthernet2/0 from LOADING to FULL, Loading Done
*Mar 26 07:40:19.927: %LDP-5-NBRCHG: LDP Neighbor 5.5.5.5:0 (1) is UP
*Mar 26 07:40:28.719: %LDP-5-NBRCHG: LDP Neighbor 2.2.2.2:0 (2) is UP
P-R3>
P-R3>
P-R3>en
P-R3#sh mpls for
P-R3#sh mpls forwarding-table
Local Label | Outgoing Label | Prefix or Tunnel Id | Bytes Label Switched | Outgoing interface | Next Hop
200 | Pop Label | 2.2.2.2/32 | 0 | Fa1/0 | 192.168.23.2
201 | 150 | 1.1.1.1/32 | 0 | Fa1/0 | 192.168.23.2
202 | Pop Label | 192.168.12.0/24 | 0 | Fa1/0 | 192.168.23.2
203 | Pop Label | 192.168.24.0/24 | 0 | Fa1/0 | 192.168.23.2
204 | 250 | 6.6.6.6/32 | 0 | Fa2/0 | 192.168.35.5
205 | Pop Label | 5.5.5.5/32 | 0 | Fa2/0 | 192.168.35.5
206 | 153 | 4.4.4.4/32 | 0 | Fa1/0 | 192.168.23.2
251 | 4.4.4.4/32 | 0 | Fa2/0 | 192.168.35.5
207 | Pop Label | 192.168.56.0/24 | 0 | Fa2/0 | 192.168.35.5
208 | Pop Label | 192.168.45.0/24 | 0 | Fa2/0 | 192.168.35.5
P-R3#


P-R4
*Mar 26 07:40:05.715: %OSPF-5-ADJCHG: Process 1, Nbr 5.5.5.5 on FastEthernet1/0 from LOADING to FULL, Loading Done
*Mar 26 07:40:18.803: %LDP-5-NBRCHG: LDP Neighbor 5.5.5.5:0 (1) is UP
*Mar 26 07:40:22.807: %LDP-5-NBRCHG: LDP Neighbor 2.2.2.2:0 (2) is UP
P-R4>
P-R4>
P-R4>
P-R4>en
P-R4#sh mp
P-R4#sh mpls for
P-R4#sh mpls forwarding-table
Local Label | Outgoing Label | Prefix or Tunnel Id | Bytes Label Switched | Outgoing interface | Next Hop
350 | 250 | 6.6.6.6/32 | 11100 | Fa1/0 | 192.168.45.5
351 | Pop Label | 5.5.5.5/32 | 0 | Fa1/0 | 192.168.45.5
352 | 154 | 3.3.3.3/32 | 0 | Fa2/0 | 192.168.24.2
252 | 3.3.3.3/32 | 0 | Fa1/0 | 192.168.45.5
353 | Pop Label | 2.2.2.2/32 | 0 | Fa2/0 | 192.168.24.2
354 | 150 | 1.1.1.1/32 | 12596 | Fa2/0 | 192.168.24.2
355 | Pop Label | 192.168.35.0/24 | 0 | Fa1/0 | 192.168.45.5
356 | Pop Label | 192.168.23.0/24 | 0 | Fa2/0 | 192.168.24.2
357 | Pop Label | 192.168.56.0/24 | 0 | Fa1/0 | 192.168.45.5
358 | Pop Label | 192.168.12.0/24 | 0 | Fa2/0 | 192.168.24.2
P-R4#



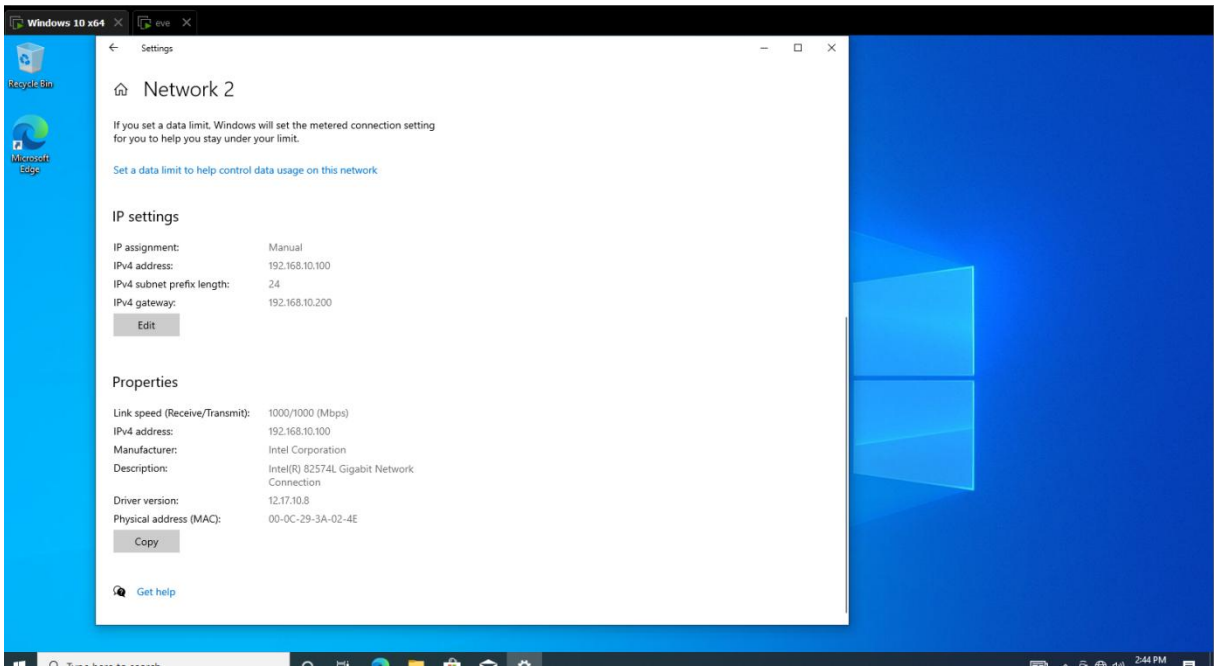


Thông tin cổng VPN:

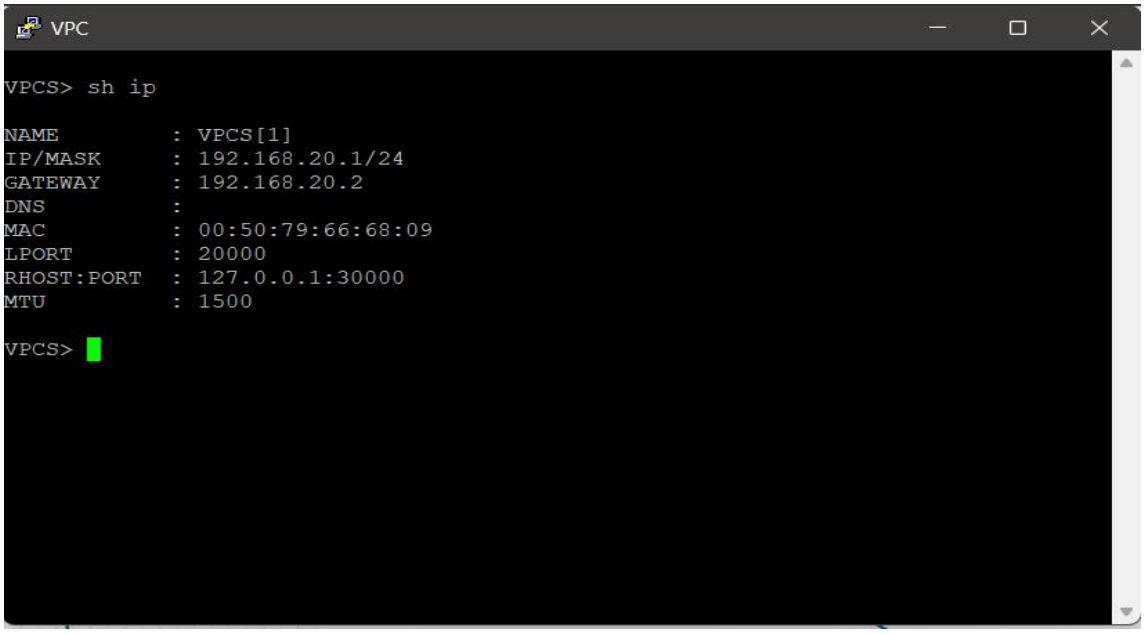
```
PE-R6#sh xconnect peer 1.1.1.1 all detail
Legend:    XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
  UP=Up       DN=Down           AD=Admin Down      IA=Inactive
  SB=Standby  HS=Hot Standby    RV=Recovering      NH=No Hardware

XC ST  Segment 1                        S1 Segment 2                        S2
------+---------------------------------+--+---------------------------------+--
UP pri   ac Fa1/0:3(Ethernet)           UP mpls 1.1.1.1:130                 UP
           Interworking: none                   Local VC label 300
                                                Remote VC label 100

PE-R6#
```

Ping giữa 2 chi nhánh:

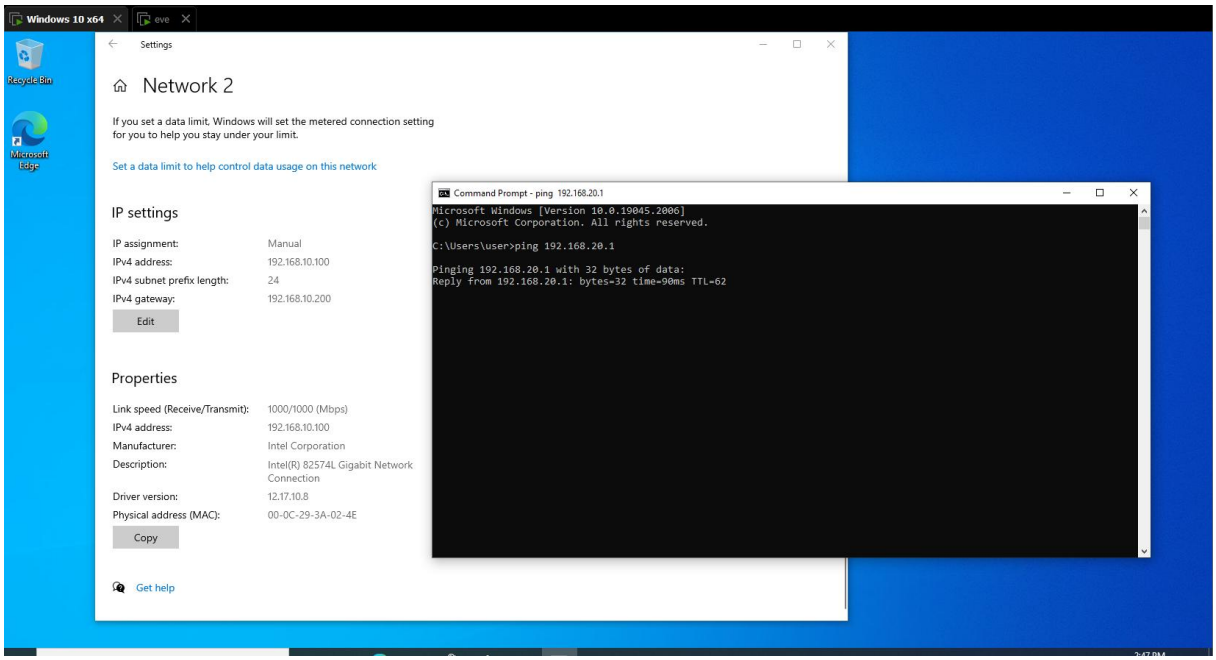
Thông tin máy ở chi nhánh 2:

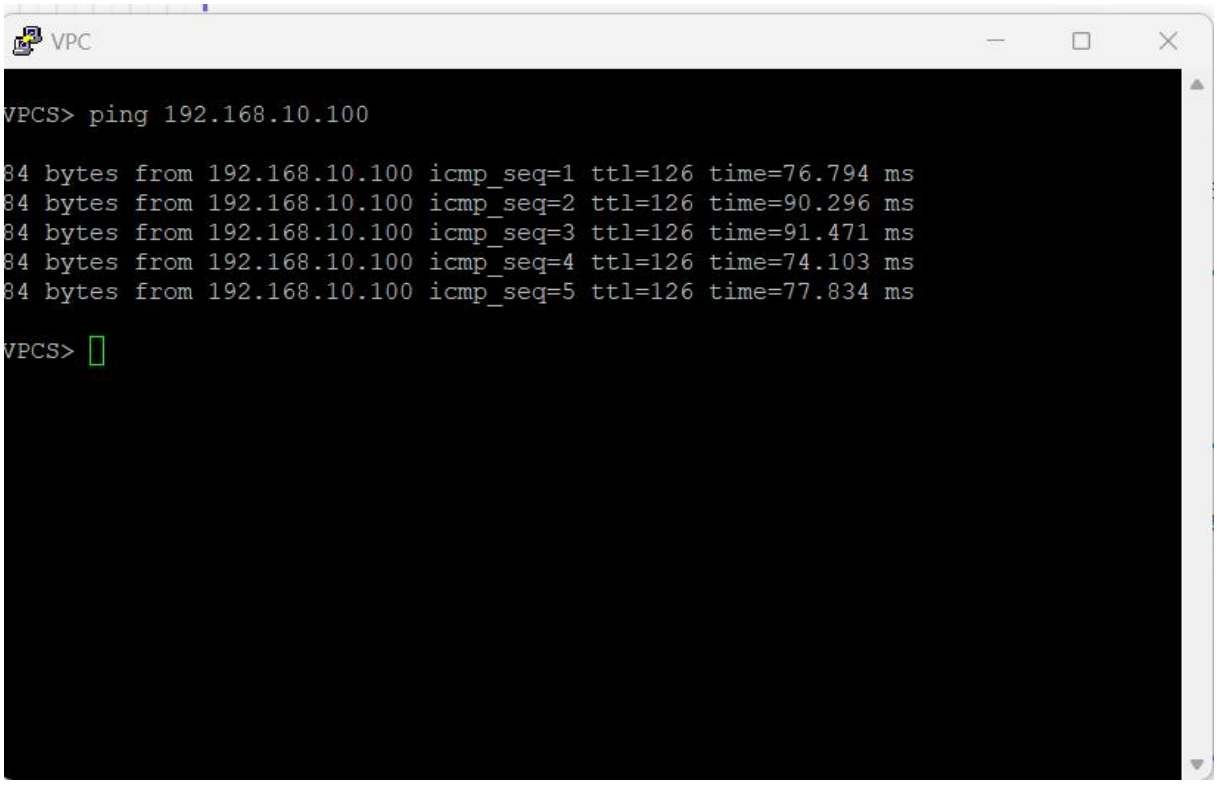


Thông tin máy ở chi nhánh 1:



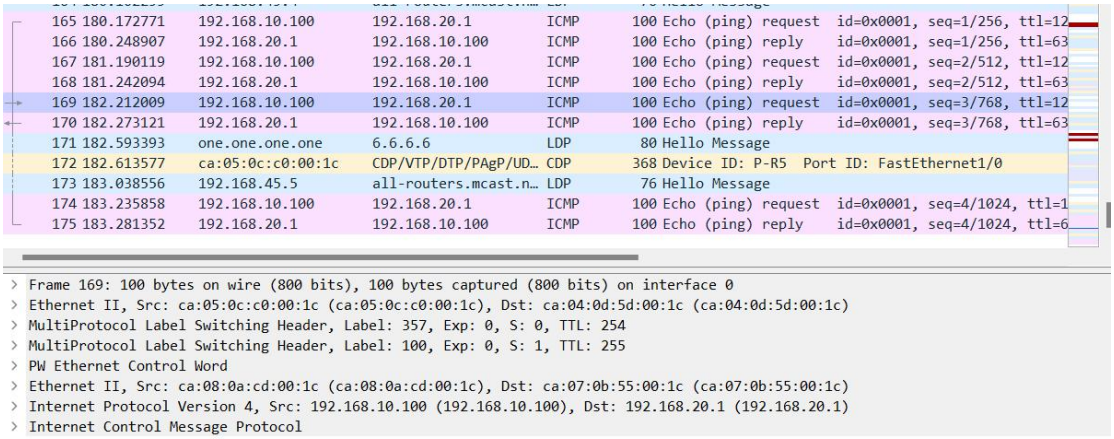
Kết quả ping:





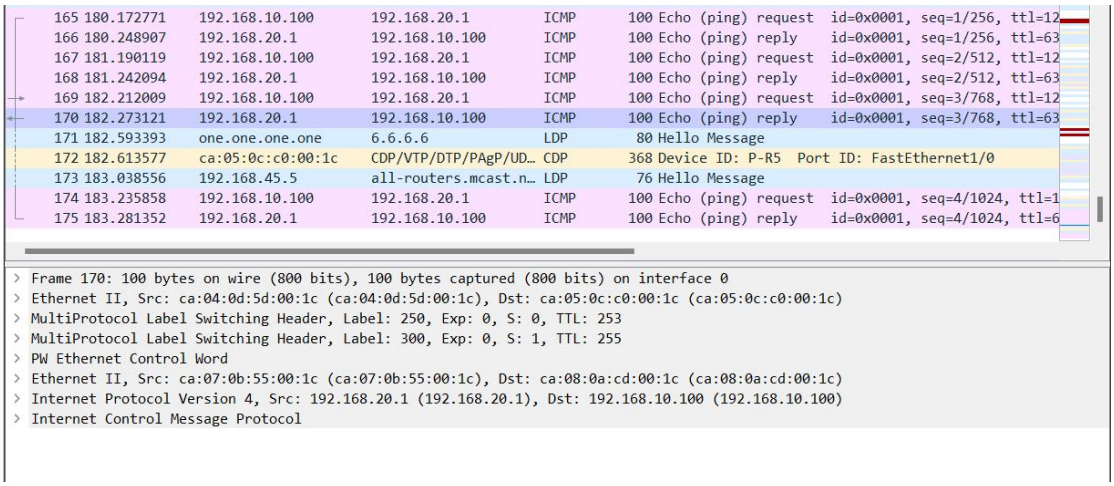
Kiểm tra bằng wireshark:

Ping từ CN2 sang CN1



165	180.172771	192.168.10.100	192.168.20.1	ICMP	100	Echo (ping) request id=0x0001, seq=1/256, ttl=12
166	180.248907	192.168.20.1	192.168.10.100	ICMP	100	Echo (ping) reply id=0x0001, seq=1/256, ttl=63
167	181.190119	192.168.10.100	192.168.20.1	ICMP	100	Echo (ping) request id=0x0001, seq=2/512, ttl=12
168	181.242094	192.168.20.1	192.168.10.100	ICMP	100	Echo (ping) reply id=0x0001, seq=2/512, ttl=63
169	182.212009	192.168.10.100	192.168.20.1	ICMP	100	Echo (ping) request id=0x0001, seq=3/768, ttl=12
170	182.273121	192.168.20.1	192.168.10.100	ICMP	100	Echo (ping) reply id=0x0001, seq=3/768, ttl=63
171	182.593393	one.one.one.one	6.6.6.6	LDP	80	Hello Message
172	182.613577	ca:05:0c:c0:00:1c	CDP/VTP/DTP/PAgP/UD…	CDP	368	Device ID: P-R5 Port ID: FastEthernet1/0
173	183.038556	192.168.45.5	all-routers.mcast.n…	LDP	76	Hello Message
174	183.235858	192.168.10.100	192.168.20.1	ICMP	100	Echo (ping) request id=0x0001, seq=4/1024, ttl=1
175	183.281352	192.168.20.1	192.168.10.100	ICMP	100	Echo (ping) reply id=0x0001, seq=4/1024, ttl=6

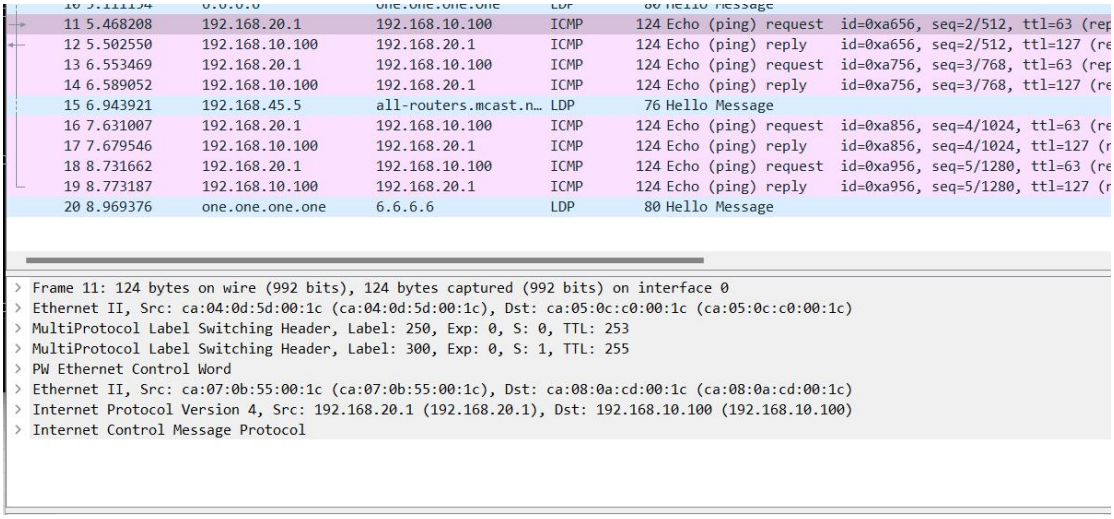
```
> Frame 169: 100 bytes on wire (800 bits), 100 bytes captured (800 bits) on interface 0
> Ethernet II, Src: ca:05:0c:c0:00:1c (ca:05:0c:c0:00:1c), Dst: ca:04:0d:5d:00:1c (ca:04:0d:5d:00:1c)
> MultiProtocol Label Switching Header, Label: 357, Exp: 0, S: 0, TTL: 254
> MultiProtocol Label Switching Header, Label: 100, Exp: 0, S: 1, TTL: 255
> PW Ethernet Control Word
> Ethernet II, Src: ca:08:0a:cd:00:1c (ca:08:0a:cd:00:1c), Dst: ca:07:0b:55:00:1c (ca:07:0b:55:00:1c)
> Internet Protocol Version 4, Src: 192.168.10.100 (192.168.10.100), Dst: 192.168.20.1 (192.168.20.1)
> Internet Control Message Protocol
```



165	180.172771	192.168.10.100	192.168.20.1	ICMP	100	Echo (ping) request id=0x0001, seq=1/256, ttl=12
166	180.248907	192.168.20.1	192.168.10.100	ICMP	100	Echo (ping) reply id=0x0001, seq=1/256, ttl=63
167	181.190119	192.168.10.100	192.168.20.1	ICMP	100	Echo (ping) request id=0x0001, seq=2/512, ttl=12
168	181.242094	192.168.20.1	192.168.10.100	ICMP	100	Echo (ping) reply id=0x0001, seq=2/512, ttl=63
169	182.212009	192.168.10.100	192.168.20.1	ICMP	100	Echo (ping) request id=0x0001, seq=3/768, ttl=12
170	182.273121	192.168.20.1	192.168.10.100	ICMP	100	Echo (ping) reply id=0x0001, seq=3/768, ttl=63
171	182.593393	one.one.one.one	6.6.6.6	LDP	80	Hello Message
172	182.613577	ca:05:0c:c0:00:1c	CDP/VTP/DTP/PAgP/UD…	CDP	368	Device ID: P-R5 Port ID: FastEthernet1/0
173	183.038556	192.168.45.5	all-routers.mcast.n…	LDP	76	Hello Message
174	183.235858	192.168.10.100	192.168.20.1	ICMP	100	Echo (ping) request id=0x0001, seq=4/1024, ttl=1
175	183.281352	192.168.20.1	192.168.10.100	ICMP	100	Echo (ping) reply id=0x0001, seq=4/1024, ttl=6

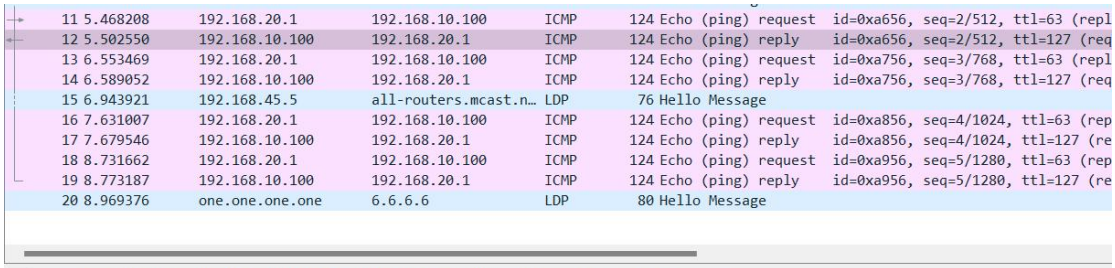
```
> Frame 170: 100 bytes on wire (800 bits), 100 bytes captured (800 bits) on interface 0
> Ethernet II, Src: ca:04:0d:5d:00:1c (ca:04:0d:5d:00:1c), Dst: ca:05:0c:c0:00:1c (ca:05:0c:c0:00:1c)
> MultiProtocol Label Switching Header, Label: 250, Exp: 0, S: 0, TTL: 253
> MultiProtocol Label Switching Header, Label: 300, Exp: 0, S: 1, TTL: 255
> PW Ethernet Control Word
> Ethernet II, Src: ca:07:0b:55:00:1c (ca:07:0b:55:00:1c), Dst: ca:08:0a:cd:00:1c (ca:08:0a:cd:00:1c)
> Internet Protocol Version 4, Src: 192.168.20.1 (192.168.20.1), Dst: 192.168.10.100 (192.168.10.100)
> Internet Control Message Protocol
```

Từ CN1 sang CN2:

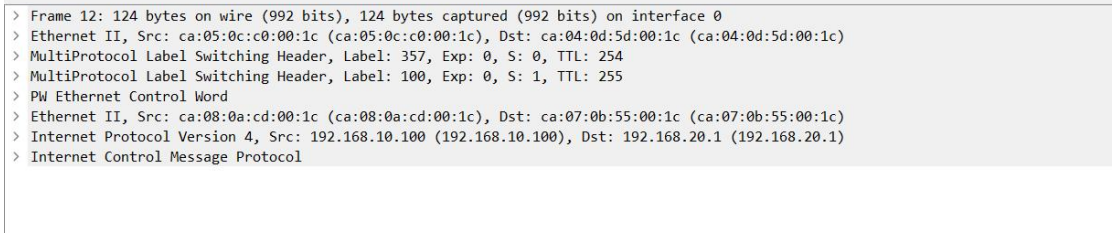


11	5.468208	192.168.20.1	192.168.10.100	ICMP	124	Echo (ping) request id=0xa656, seq=2/512, ttl=63 (rep
12	5.502550	192.168.10.100	192.168.20.1	ICMP	124	Echo (ping) reply id=0xa656, seq=2/512, ttl=127 (re
13	6.553469	192.168.20.1	192.168.10.100	ICMP	124	Echo (ping) request id=0xa756, seq=3/768, ttl=63 (rep
14	6.589052	192.168.10.100	192.168.20.1	ICMP	124	Echo (ping) reply id=0xa756, seq=3/768, ttl=127 (re
15	6.943921	192.168.45.5	all-routers.mcast.n…	LDP	76	Hello Message
16	7.631007	192.168.20.1	192.168.10.100	ICMP	124	Echo (ping) request id=0xa856, seq=4/1024, ttl=63 (re
17	7.679546	192.168.10.100	192.168.20.1	ICMP	124	Echo (ping) reply id=0xa856, seq=4/1024, ttl=127 (r
18	8.731662	192.168.20.1	192.168.10.100	ICMP	124	Echo (ping) request id=0xa956, seq=5/1280, ttl=63 (re
19	8.773187	192.168.10.100	192.168.20.1	ICMP	124	Echo (ping) reply id=0xa956, seq=5/1280, ttl=127 (r
20	8.969376	one.one.one.one	6.6.6.6	LDP	80	Hello Message

```
> Frame 11: 124 bytes on wire (992 bits), 124 bytes captured (992 bits) on interface 0
> Ethernet II, Src: ca:04:0d:5d:00:1c (ca:04:0d:5d:00:1c), Dst: ca:05:0c:c0:00:1c (ca:05:0c:c0:00:1c)
> MultiProtocol Label Switching Header, Label: 250, Exp: 0, S: 0, TTL: 253
> MultiProtocol Label Switching Header, Label: 300, Exp: 0, S: 1, TTL: 255
> PW Ethernet Control Word
> Ethernet II, Src: ca:07:0b:55:00:1c (ca:07:0b:55:00:1c), Dst: ca:08:0a:cd:00:1c (ca:08:0a:cd:00:1c)
> Internet Protocol Version 4, Src: 192.168.20.1 (192.168.20.1), Dst: 192.168.10.100 (192.168.10.100)
> Internet Control Message Protocol
```



11	5.468208	192.168.20.1	192.168.10.100	ICMP	124	Echo (ping) request id=0xa656, seq=2/512, ttl=63 (repl
12	5.502550	192.168.10.100	192.168.20.1	ICMP	124	Echo (ping) reply id=0xa656, seq=2/512, ttl=127 (req
13	6.553469	192.168.20.1	192.168.10.100	ICMP	124	Echo (ping) request id=0xa756, seq=3/768, ttl=63 (repl
14	6.589052	192.168.10.100	192.168.20.1	ICMP	124	Echo (ping) reply id=0xa756, seq=3/768, ttl=127 (req
15	6.943921	192.168.45.5	all-routers.mcast.n…	LDP	76	Hello Message
16	7.631007	192.168.20.1	192.168.10.100	ICMP	124	Echo (ping) request id=0xa856, seq=4/1024, ttl=63 (rep
17	7.679546	192.168.10.100	192.168.20.1	ICMP	124	Echo (ping) reply id=0xa856, seq=4/1024, ttl=127 (re
18	8.731662	192.168.20.1	192.168.10.100	ICMP	124	Echo (ping) request id=0xa956, seq=5/1280, ttl=63 (rep
19	8.773187	192.168.10.100	192.168.20.1	ICMP	124	Echo (ping) reply id=0xa956, seq=5/1280, ttl=127 (re
20	8.969376	one.one.one.one	6.6.6.6	LDP	80	Hello Message



```
> Frame 12: 124 bytes on wire (992 bits), 124 bytes captured (992 bits) on interface 0
> Ethernet II, Src: ca:05:0c:c0:00:1c (ca:05:0c:c0:00:1c), Dst: ca:04:0d:5d:00:1c (ca:04:0d:5d:00:1c)
> MultiProtocol Label Switching Header, Label: 357, Exp: 0, S: 0, TTL: 254
> MultiProtocol Label Switching Header, Label: 100, Exp: 0, S: 1, TTL: 255
> PW Ethernet Control Word
> Ethernet II, Src: ca:08:0a:cd:00:1c (ca:08:0a:cd:00:1c), Dst: ca:07:0b:55:00:1c (ca:07:0b:55:00:1c)
> Internet Protocol Version 4, Src: 192.168.10.100 (192.168.10.100), Dst: 192.168.20.1 (192.168.20.1)
> Internet Control Message Protocol
```