

Part1:

1. After you complete Steps 1-1

a) Can h2 ping h3? Briefly explain why or why not.

Yes，單獨一個 subnet 內的封包傳遞不需透過 router，且此時的 switch 是正常運行的，所以能夠 h2 與 h3 之間可以正常傳遞封包。

b) Can h2 ping h4? Briefly explain why or why not.

No，透過router聯接的外網連線規則並未建立，封包無法傳出去。

Complete topology.py so that all hosts, except h1, can ping one another.

Take screenshot to show that your topology configuration is correct.

```
kaorip@kaorip-VirtualBox:~$ sudo python /home/kaorip/Desktop/lab2/topology.py
h1 doesn't have connectivity to 192.168.1.65
h1 doesn't have connectivity to 192.168.1.66
h1 doesn't have connectivity to 192.168.3.1
h1 doesn't have connectivity to 192.168.3.2
WRONG ANSWER
mininet> 
```

Part2:

3. Capture DHCP messages and show the IPs and MACs

No.	Time	Source	Destination	Protocol	Length	Client MAC address	Source	Info
5	19.767660891	0.0.0.0	255.255.255.255	DHCP	342	62:6d:70:81:c3:f4	62:6d:70:81:c3:f4	DHCP Request - Transaction ID 0xe162292a
6	19.768100831	192.168.1.4	255.255.255.255	DHCP	342	62:6d:70:81:c3:f4	5a:d0:29:64:01:86	DHCP NAK - Transaction ID 0xe162292a
12	29.939990696	0.0.0.0	255.255.255.255	DHCP	342	62:6d:70:81:c3:f4	62:6d:70:81:c3:f4	DHCP Discover - Transaction ID 0xae6bc284
15	30.947466230	192.168.1.4	192.168.1.12	DHCP	342	62:6d:70:81:c3:f4	5a:d0:29:64:01:86	DHCP Offer - Transaction ID 0xae6bc284
16	30.947586160	0.0.0.0	255.255.255.255	DHCP	342	62:6d:70:81:c3:f4	62:6d:70:81:c3:f4	DHCP Request - Transaction ID 0xae6bc284
17	30.950477423	192.168.1.4	192.168.1.12	DHCP	342	62:6d:70:81:c3:f4	5a:d0:29:64:01:86	DHCP ACK - Transaction ID 0xae6bc284

4. Can hosts other than h1 acquire IP addresses from DHCP server? Briefly explain your answer.

一般情況下無法，首先在此题目的結構之下，h1以外的hosts，並無法收到DHCP Broadcast，原因是一般router並無法轉送此廣播到其他subnet

Part3:

5. What does r1 do on the packets from h1 to h5, and h5 to h1, respectively?

Capture packets to explain your answers.

r1-eth0:

Frame	Source	Destination	Protocol	Length	Client MAC address	Source	Info
1 0.000000000	192.168.1.12	192.168.3.2	ICMP	98	62:6d:70:81:c3:f4	62:6d:70:81:c3:f4	Echo (ping) request id=0x21a4, seq=1/256, ttl=64 (reply in 2)
2 0.000000000	192.168.3.2	192.168.1.12	ICMP	98	9a:95:9a:2e:2e:86	62:6d:70:81:c3:f4	Echo (ping) reply id=0x21a4, seq=1/256, ttl=64 (request in 1)

r1-eth1:

3 0.000000000	192.168.1.12	192.168.3.2	ICMP	98	62:6d:70:81:c3:f4	62:6d:70:81:c3:f4	Echo (ping) request id=0x21a4, seq=1/256, ttl=64 (reply in 4)
4 0.000127870	192.168.3.2	192.168.1.12	ICMP	98	9a:95:9a:2e:2e:86	62:6d:70:81:c3:f4	Echo (ping) reply id=0x21a4, seq=1/256, ttl=64 (request in 3)

如圖所示，可以看到h1發出request之後，會由r1-eth1接收封包，再由r1-eth0轉送出去，轉送之後，封包的Source MAC Address會改為r1-eth0。同理，r1-eth0接收reply之後，會將封包的Source MAC Address改為r1-eth1，再送給h1。

6. Capture all ICMP messages received by h1 and explain why h1 can only derive only 1st, 2nd, and 5th hops details.

17	0.000470839	192.168.1.62	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
18	0.000503979	192.168.1.62	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
19	0.000513899	192.168.1.62	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
20	0.000523359	10.0.0.1	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
21	0.000531649	10.0.0.1	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
22	0.000538379	10.0.0.1	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
23	0.000582879	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
24	0.000588919	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
25	0.000594879	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
26	0.000598719	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
28	0.001818393	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
30	0.001833803	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)

由於 h1 的封包必須由 r1 轉送，但 r1 的規則中並不認識 192.168.3.0/24 以外的 subnet，所以 r1 送出的封包無法以此 subnet 和自身 gateway 以外的網域作為目的地，因此 r3 與 r4 無法顯示在 table 上。

7. H1 uses some ICMP messages to derive 1st and 2nd hop details. What are the type(s) and sender(s) of the ICMP messages?

17	0.000470839	192.168.1.62	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
18	0.000503979	192.168.1.62	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
19	0.000513899	192.168.1.62	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
20	0.000523359	10.0.0.1	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
21	0.000531649	10.0.0.1	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)
22	0.000538379	10.0.0.1	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Time-to-live exceeded (Time to live exceeded in transit)

1st hop:

Type: 11 TTL exceeded

Sender: 192.168.1.62

2nd hop:

Type: 11 TTL exceeded

Sender: 10.0.0.1

8. H1 uses some ICMP messages to derive 5th hop details. What are the type(s) and sender(s) of the ICMP messages?

23	0.000582879	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
24	0.000588919	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
25	0.000594879	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
26	0.000598719	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
28	0.001818393	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)
30	0.001833803	192.168.3.2	192.168.1.12	ICMP	102	9a:95:9a:2e:2e:86	Destination unreachable (Port unreachable)

5th hop:

Type: 3 Destination unreachable

Sender: 192.168.3.2

Bonus:

- Ideally, we should have all the hop details as follows.

```
mininet> h1 traceroute h5
traceroute to 192.168.3.2 (192.168.3.2), 30 hops max, 60 byte packets
 1  _gateway (192.168.1.62)  0.283 ms  0.015 ms  0.006 ms
 2  10.0.1.1 (10.0.1.1)    0.017 ms  0.008 ms  0.008 ms
 3  10.0.0.2 (10.0.0.2)    0.016 ms  0.009 ms  0.012 ms
 4  10.0.2.3 (10.0.2.3)    0.017 ms  0.011 ms  0.018 ms
 5  192.168.3.2 (192.168.3.2)  0.193 ms  0.026 ms  0.027 ms
```

- Try to configure the nodes so that traceroute can output the above hop details.
- Describe the configuration you added
 - Add the configuration commands in your python script

在 config() 中，新增 r1 與 r2 的規則，規則如下：

```
routers['r1'].cmd('route add -net 10.0.0.0/24 gw 10.0.1.1')
```

```
routers['r1'].cmd('route add -net 10.0.2.0/24 gw 10.0.1.1')
```

```
routers['r2'].cmd('route add -net 10.0.2.0/24 gw 10.0.0.2')
```

確保透過 r1 送出的封包可以將目的位址訂為 r3 與 r4

而封包能正常送達之後，traceroute table 便能顯示出來。