

1.

h1 sends an ARP request to get h2's MAC address.

h2 receives the ARP request and replies.

h1 receives the ARP reply and sends the ICMP request.

h2 receives the ICMP request and replies.

h1 receives the ICMP replies.

h1:

```
14:48:31.151064 ARP, Request who-has 10.0.0.1 tell 10.0.0.2, length 28
14:48:31.151131 ARP, Reply 10.0.0.1 is-at 0e:1c:bf:f7:4c:5f (oui Unknown), length 28
14:48:32.176166 IP6 fe80::e0da:6cff:fe00:eb7e > ip6-allrouters: ICMP6, router solicitation, length 16
14:48:32.176202 IP6 fe80::c1c:bfff:fe07:4c5f > ip6-allrouters: ICMP6, router solicitation, length 16
```

h2:

```
14:48:26.056743 ARP, Request who-has 10.0.0.2 tell 10.0.0.1, length 28
14:48:26.056923 ARP, Reply 10.0.0.2 is-at 42:06:1e:32:7c:52 (oui Unknown), length 28
14:48:26.057910 IP 10.0.0.1 > 10.0.0.2: ICMP echo request, id 6079, seq 1, length 64
14:48:26.057924 IP 10.0.0.2 > 10.0.0.1: ICMP echo reply, id 6079, seq 1, length 64
```

```
mininet> h1 ping h2 -c 1
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=1.72 ms

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.723/1.723/1.723/0.000 ms
```

2.

h1 sends an ARP request to get h3's MAC address.

h3 receives the ARP request and replies.

h1 receives the ARP reply and sends the ICMP request.

h3 receives the ICMP request and replies.

The controller blocks the packet from port 3, h1 does not receive the ICMP reply.

h1:

```
15:03:35.593186 ARP, Request who-has 10.0.0.3 tell 10.0.0.1, length 28
15:03:35.595275 ARP, Reply 10.0.0.3 is-at ea:a5:4a:e8:34:a3 (oui Unknown), length 28
15:03:35.595352 IP 10.0.0.1 > 10.0.0.3: ICMP echo request, id 6547, seq 1, length 64
```

h3:

```
15:03:35.595122 ARP, Request who-has 10.0.0.3 tell 10.0.0.1, length 28
15:03:35.595199 ARP, Reply 10.0.0.3 is-at ea:a5:4a:e8:34:a3 (oui Unknown), length 28
15:03:35.595432 IP 10.0.0.1 > 10.0.0.3: ICMP echo request, id 6547, seq 1, length 64
15:03:35.595522 IP 10.0.0.3 > 10.0.0.1: ICMP echo reply, id 6547, seq 1, length 64
```

```
mininet> h1 ping h3 -c 1
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
--- 10.0.0.3 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms
```

3.

h3 sends an ARP request to get h2's MAC address.

h2 receives the ARP request and replies.

h3 receives the ARP reply and sends the ICMP request.

The controller blocks the packet from port 3, h2 does not receive the ICMP request.

h3:

```
15:12:30.891367 ARP, Request who-has 10.0.0.2 tell 10.0.0.3, length 28
15:12:30.891652 ARP, Reply 10.0.0.2 is-at ae:5d:dc:8d:80:8b (oui Unknown), length 28
15:12:30.891654 IP 10.0.0.3 > 10.0.0.2: ICMP echo request, id 6707, seq 1, length 64
```

h2:

```
15:12:30.891535 ARP, Request who-has 10.0.0.2 tell 10.0.0.3, length 28
15:12:30.891600 ARP, Reply 10.0.0.2 is-at ae:5d:dc:8d:80:8b (oui Unknown), length 28
```

```
mininet> h3 ping h2 -c 1
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms
```

4.

h1 sends ARP requests, but there's no GRE tunnel between two VMs, so h5 will not receive anything.

h1:

```
Listening on h1-eth0, link type EN10MB (Ethernet), capture size 262144 bytes
15:33:42.558750 ARP, Request who-has 10.0.2.5 tell 10.0.0.1, length 28
15:33:43.566994 ARP, Request who-has 10.0.2.5 tell 10.0.0.1, length 28
15:33:44.591012 ARP, Request who-has 10.0.2.5 tell 10.0.0.1, length 28

```

h5:

nothing received

```
mininet> h1 ping 10.0.2.5 -c 1
PING 10.0.2.5 (10.0.2.5) 56(84) bytes of data.
64 bytes from 10.0.2.5: icmp_seq=1 ttl=64 time=3.79 ms

--- 10.0.2.5 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 3.789/3.789/3.789/0.000 ms

```

5.

h1 sends an ARP request to get h5's MAC address.

h5 receives the ARP request and replies.

h1 receives the ARP reply and sends the ICMP request.

h5 receives the ICMP request and replies.

h1 receives the ICMP replies.

Since the GRE tunnel is built, the ARP request can be sent to h5

h1:

```
15:47:39.790214 ARP, Request who-has 10.0.2.5 tell 10.0.0.1, length 28
15:47:39.792603 ARP, Reply 10.0.2.5 is-at de:50:4b:de:f7:63 (oui Unknown), length 28
15:47:39.792614 IP 10.0.0.1 > 10.0.2.5: ICMP echo request, id 7433, seq 1, length 64
15:47:39.793905 IP 10.0.2.5 > 10.0.0.1: ICMP echo reply, id 7433, seq 1, length 64
```

h5:

```
15:47:39.769278 ARP, Request who-has 10.0.2.5 tell 10.0.0.1, length 28
15:47:39.769353 ARP, Reply 10.0.2.5 is-at de:50:4b:de:f7:63 (oui Unknown), length 28
15:47:39.770679 IP 10.0.0.1 > 10.0.2.5: ICMP echo request, id 7433, seq 1, length 64
15:47:39.770701 IP 10.0.2.5 > 10.0.0.1: ICMP echo reply, id 7433, seq 1, length 64
```

6.

h1 sends an ARP request to get h7's MAC address.

h7 receives the ARP request and replies.

h1 receives the ARP reply and sends the ICMP request.

h7 receives the ICMP request and replies.

The controller blocks the packet from port 3, h1 does not receive the ICMP reply.

h1:

```
15:51:15.827093 ARP, Request who-has 10.0.2.7 tell 10.0.0.1, length 28
15:51:15.829097 ARP, Reply 10.0.2.7 is-at 76:91:a5:9f:b5:ad (oui Unknown), length 28
15:51:15.829153 IP 10.0.0.1 > 10.0.2.7: ICMP echo request, id 7582, seq 1, length 64
```

h7:

```
15:51:15.805819 ARP, Request who-has 10.0.2.7 tell 10.0.0.1, length 28
15:51:15.805839 ARP, Reply 10.0.2.7 is-at 76:91:a5:9f:b5:ad (oui Unknown), length 28
15:51:15.807372 IP 10.0.0.1 > 10.0.2.7: ICMP echo request, id 7582, seq 1, length 64
15:51:15.807396 IP 10.0.2.7 > 10.0.0.1: ICMP echo reply, id 7582, seq 1, length 64
```

```
mininet> h1 ping h7 -c 1
ping: h7: Temporary failure in name resolution
mininet> h1 ping 10.0.2.7 -c 1
PING 10.0.2.7 (10.0.2.7) 56(84) bytes of data.

--- 10.0.2.7 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms
```

7.

h7 sends ARP requests, but the packets from port 3 will be dropped, the packet sent from h7 will not be forwarded and thus h1 will not receive any packet.

h7:

```
15:56:27.172732 ARP, Request who-has 10.0.0.1 tell 10.0.2.7, length 28  
15:56:28.188554 ARP, Request who-has 10.0.0.1 tell 10.0.2.7, length 28  
15:56:29.212568 ARP, Request who-has 10.0.0.1 tell 10.0.2.7, length 28
```

h1:

nothing received

```
mininet> h7 ping 10.0.0.1 -c 1  
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.  
From 10.0.2.7 icmp_seq=1 Destination Host Unreachable  
  
--- 10.0.0.1 ping statistics ---  
1 packets transmitted, 0 received, +1 errors, 100% packet loss, time 0ms
```

8.

For question 6:

- If the ARP request is dropped, the outcome will be the same as in question 4. But the explanation is different, in question 4, the packets cannot be sent to the destination since there is no GRE tunnel, while in modified question 6, it is because the packets are dropped (the filter table specified the drop action)

h1:

```
Listening on h1-eth0, link-type EN10MB (Ethernet), capture size 262144 bytes
15:33:42.558750 ARP, Request who-has 10.0.2.5 tell 10.0.0.1, length 28
15:33:43.566994 ARP, Request who-has 10.0.2.5 tell 10.0.0.1, length 28
15:33:44.591012 ARP, Request who-has 10.0.2.5 tell 10.0.0.1, length 28

```

h5:

nothing received

- If the ICMP request is dropped, the outcome will be different as in question 4, and so does the explanation

h1:

```
15:51:15.827093 ARP, Request who-has 10.0.2.7 tell 10.0.0.1, length 28
15:51:15.829097 ARP, Reply 10.0.2.7 is-at 76:91:a5:9f:b5:ad (oui Unknown), length 28
15:51:15.829153 IP 10.0.0.1 > 10.0.2.7: ICMP echo request, id 7582, seq 1, length 64

```

h7:

```
15:51:15.805819 ARP, Request who-has 10.0.2.7 tell 10.0.0.1, length 28
15:51:15.805839 ARP, Reply 10.0.2.7 is-at 76:91:a5:9f:b5:ad (oui Unknown), length 28

```

For question 7:

- If the ARP request is dropped, the outcome will not change and is the same as in question 4 (or in question 4, the problem set is h1 ping h7, while in question 7, it's h7 ping h1, which is different from the problem set of question 4) The explanation is different, in question 4, the packets cannot be sent to the destination since there is no GRE tunnel, while in question 7, it is because the packets are dropped because of the control function.

h7:

```
15:56:27.172732 ARP, Request who-has 10.0.0.1 tell 10.0.2.7, length 28
15:56:28.188554 ARP, Request who-has 10.0.0.1 tell 10.0.2.7, length 28
15:56:29.212568 ARP, Request who-has 10.0.0.1 tell 10.0.2.7, length 28

```

h1:

nothing received

- There is no ICMP packet sent in question 7, no need to consider if ICMP request is dropped

9.

如果拓譜如此作業設定，只有 port 1~4 的話，只允許 port 1、port 2 的封包通過
等效於丟棄 port 3、port 4 的封包。

如果拓譜設定和此作業不同，不只 port 1~4 的話，新的 filter_table2 會比原先的
table2 丟棄更多封包（丟棄 port number > 4 的封包）。