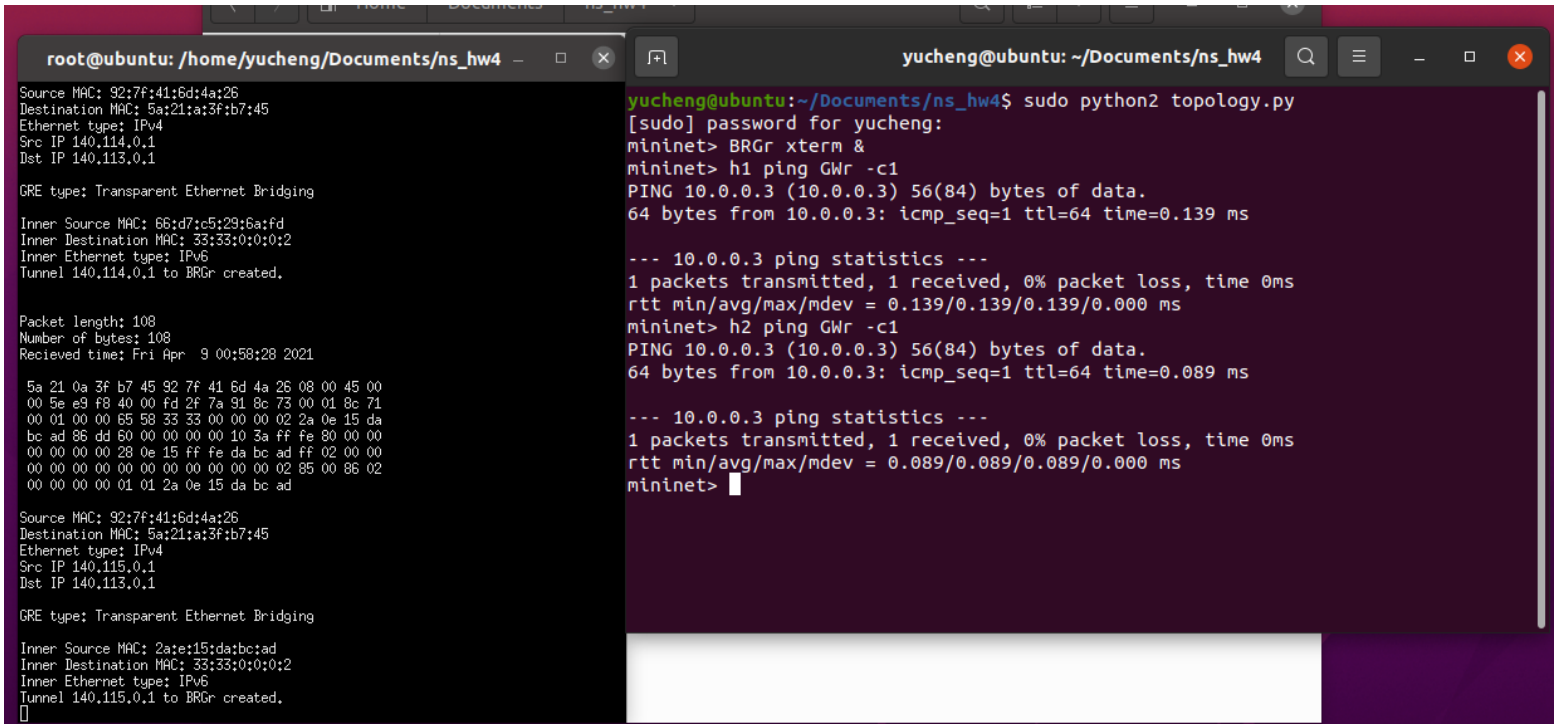
NS Lab4 Report

1. ping result:



2. show all interfaces:

before tunnel create (ping failed):

```
yucheng@ubuntu:~/Documents/ns_hw4$ sudo python2 topology.py
mininet> BRGr ifconfig
BRGr-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.0.8  netmask 255.0.0.0  broadcast 10.255.255.255
        inet6 fe80::60f0:88ff:fe00:a86e  prefixlen 64  scopeid 0x20<link>
        ether 62:f0:88:00:a8:6e  txqueuelen 1000  (Ethernet)
        RX packets 8  bytes 696 (696.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 6  bytes 516 (516.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

BRGr-eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 140.113.0.1  netmask 255.255.0.0  broadcast 140.113.255.255
        inet6 fe80::1c22:63ff:fe17:799b  prefixlen 64  scopeid 0x20<link>
        ether 1e:22:63:17:79:9b  txqueuelen 1000  (Ethernet)
        RX packets 19  bytes 1950 (1.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 19  bytes 2286 (2.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

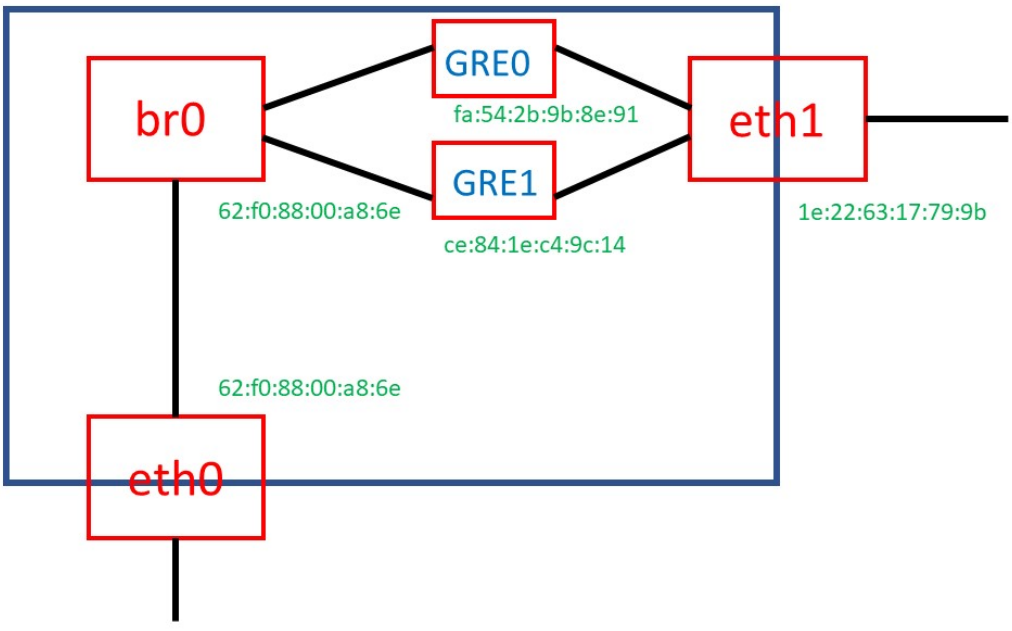
after tunnel created (ping success):

```
mininet> BRGr ifconfig
BRGr-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.0.8  netmask 255.0.0.0  broadcast 10.255.255.255
        inet6 fe80::60f0:88ff:fe00:a86e  prefixlen 64  scopeid 0x20<link>
        ether 62:f0:88:00:a8:6e  txqueuelen 1000  (Ethernet)
        RX packets 12  bytes 976 (976.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 32  bytes 2480 (2.4 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

BRGr-eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 140.113.0.1  netmask 255.255.0.0  broadcast 140.113.255.255
        inet6 fe80::1c22:63ff:fe17:799b  prefixlen 64  scopeid 0x20<link>
        ether 1e:22:63:17:79:9b  txqueuelen 1000  (Ethernet)
        RX packets 62  bytes 6580 (6.5 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 91  bytes 10348 (10.3 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

GRE0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1462
        inet6 fe80::f854:2bff:fe9b:8e91  prefixlen 64  scopeid 0x20<link>
        ether fa:54:2b:9b:8e:91  txqueuelen 1000  (Ethernet)
        RX packets 5  bytes 350 (350.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 29  bytes 1864 (1.8 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

GRE1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1462
        inet6 fe80::cc84:1eff:fec4:9c14  prefixlen 64  scopeid 0x20<link>
        ether ce:84:1e:c4:9c:14  txqueuelen 1000  (Ethernet)
        RX packets 5  bytes 350 (350.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 20  bytes 1256 (1.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

br0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1462
        inet6 fe80::60f0:88ff:fe00:a86e  prefixlen 64  scopeid 0x20<link>
        ether 62:f0:88:00:a8:6e  txqueuelen 1000  (Ethernet)
        RX packets 12  bytes 672 (672.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 12  bytes 984 (984.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
```

3. Interconnection diagram:

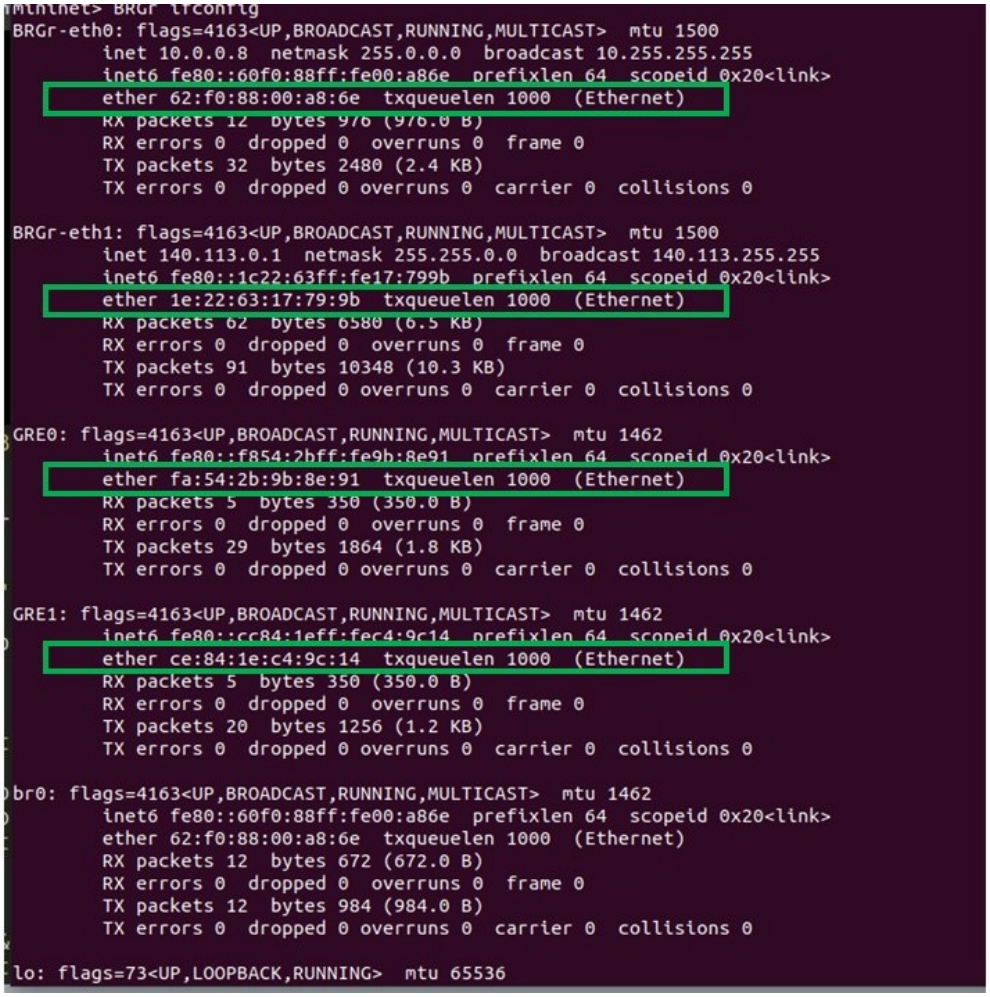
```
mininet> BRGr ifconfig
BRGr-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.0.8  netmask 255.0.0.0  broadcast 10.255.255.255
        inet6 fe80::60f0:88ff:fe00:a86e  prefixlen 64  scopeid 0x20<link>
        ether 62:f0:88:00:a8:6e  txqueuelen 1000  (Ethernet)
        RX packets 12  bytes 976 (976.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 32  bytes 2480 (2.4 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

BRGr-eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 140.113.0.1  netmask 255.255.0.0  broadcast 140.113.255.255
        inet6 fe80::1c22:63ff:fe17:799b  prefixlen 64  scopeid 0x20<link>
        ether 1e:22:63:17:79:9b  txqueuelen 1000  (Ethernet)
        RX packets 62  bytes 6580 (6.5 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 91  bytes 10348 (10.3 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

GRE0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1462
        inet6 fe80::f854:2bff:fe9b:8e91  prefixlen 64  scopeid 0x20<link>
        ether fa:54:2b:9b:8e:91  txqueuelen 1000  (Ethernet)
        RX packets 5  bytes 350 (350.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 29  bytes 1864 (1.8 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

GRE1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1462
        inet6 fe80::cc84:1eff:fec4:9c14  prefixlen 64  scopeid 0x20<link>
        ether ce:84:1e:c4:9c:14  txqueuelen 1000  (Ethernet)
        RX packets 5  bytes 350 (350.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 20  bytes 1256 (1.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

br0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1462
        inet6 fe80::60f0:88ff:fe00:a86e  prefixlen 64  scopeid 0x20<link>
        ether 62:f0:88:00:a8:6e  txqueuelen 1000  (Ethernet)
        RX packets 12  bytes 672 (672.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 12  bytes 984 (984.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
```

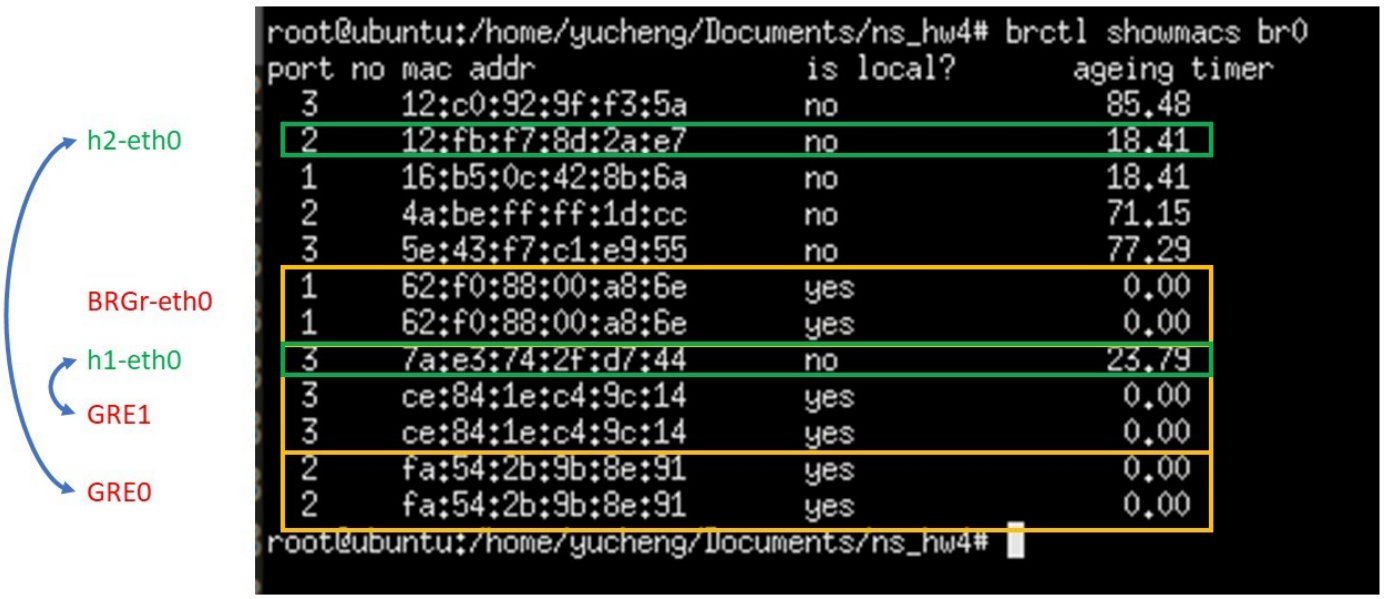
BRGr



在 tunnel 還沒建立前，interfaces 如上題圖一，只有 eth0 和 eth1 這兩個 physical interface。而 tunnel 建立後，增加了 br0、GRE0、GRE1 這三個 logical interface，路徑圖由上圖所示。br0 是一個 linux bridge，而 GRE0、GRE1 是扮演 gretap 的角色。封包會依 host 不同而選擇走不同的 tunnel，下題會有更詳細的說明。

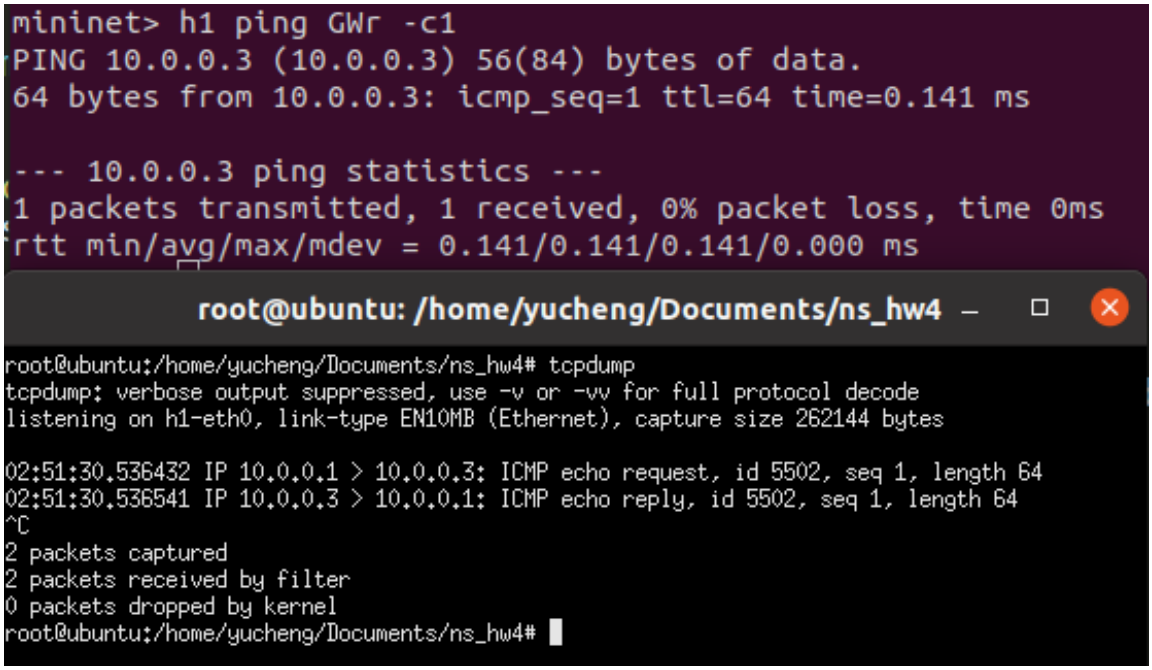
4. BRGr determines gretap:





BRGr 裡的 bridge br0 會做 MAC learning，將 h1、h2 的 MAC Address 存進自己的 MAC Address table。如上圖所示，若要傳送封包給 h1，就去 lookup MAC Address table，就知道要走 port 3，也就是 GRE1；h2 同理，走 port 2，也就是 GRE0。

5. h1 aware of GRE tunnel:



由上圖可見，h1 並不會知道自己跟 GWr 其實並不在同一個 LAN。

他們的 ip 都是 10.0.0 開頭的，因此以 h1 的角度來看，GWr 跟他是

在同一個 LAN。但實際上是透過 tunnel 將他們連在一起的。