

1. DNS request packet

```
1 0.000000000 10.0.2.15 8.8.8.8 DNS 87 Standard query 0x7b10 A cse.nsysu.edu.tw OPT
```

(1)

```
▼ Ethernet II, Src: PcsCompu_e0:41:5f (08:00:27:e0:41:5f), Dst: RealtekU_12:35:02 (52:54:00:12:35:02)
  ► Destination: RealtekU_12:35:02 (52:54:00:12:35:02)
  ► Source: PcsCompu_e0:41:5f (08:00:27:e0:41:5f)
  Type: IPv4 (0x0800)
```

a: source:41:5f
destination:35:02

b: IPv4

(2)

```
Internet Protocol Version 4, Src: 10.0.2.15, Dst: 8.8.8.8
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  ► Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
  Total Length: 73
  Identification: 0xb836 (47158)
  ► Flags: 0x40, Don't fragment
  ...0 0000 0000 0000 = Fragment Offset: 0
  Time to Live: 64
  Protocol: UDP (17)
  Header Checksum: 0x664f [validation disabled]
  [Header checksum status: Unverified]
  Source Address: 10.0.2.15
  Destination Address: 8.8.8.8
```

a: source:10.0.2.15
destination:8.8.8.8

b: Header length:20bytes
Total packet length:73

c: 17 UDP

(3)

```
User Datagram Protocol, Src Port: 52846, Dst Port: 53
  Source Port: 52846
  Destination Port: 53
  Length: 53
  Checksum: 0x1c65 [unverified]
  [Checksum Status: Unverified]
  [Stream index: 0]
  ► [Timestamps]
  UDP payload (45 bytes)
```

a: client ephemeral port number : 52846
the server well-known port number:53

b: dns

(4)

```
▼ Domain Name System (query)
  Transaction ID: 0x7b10
  ▼ Flags: 0x0120 Standard query
    0... .. = Response: Message is a query
    .000 0... .. = Opcode: Standard query (0)
    ....0... .. = Truncated: Message is not truncated
    ....1... .. = Recursion desired: Do query recursively
    ....0... .. = Z: reserved (0)
    ....1... .. = AD bit: Set
    ....0... .. = Non-authenticated data: Unacceptable
  Questions: 1
  Answer RRs: 0
  Authority RRs: 0
  Additional RRs: 1
  ▼ Queries
    ► cse.nsysu.edu.tw: type A, class IN
```

a: flag最左bit

- b: 0x7b10
- c: Queries

2.DNS response packet

7	0.084954315	8.8.8.8	10.0.2.15	DNS	103 Standard query response 0x7b10 A cse.nsysu.edu.tw A 140.117.13.241 OPT
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(1)

```
Ethernet II, Src: RealtekU_12:35:02 (52:54:00:12:35:02), Dst: PcsCompu_e0:41:5f (08:00:27:e0:41:5f)
  Destination: PcsCompu_e0:41:5f (08:00:27:e0:41:5f)
  Source: RealtekU_12:35:02 (52:54:00:12:35:02)
  Type: IPv4 (0x0800)
```

- a: source:35:02
destination:41:5f

b: IPv4

(2)

```
Internet Protocol Version 4, Src: 8.8.8.8, Dst: 10.0.2.15
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
  Total Length: 89
  Identification: 0x2dd3 (11731)
  Flags: 0x00
  ...0 0000 0000 0000 = Fragment Offset: 0
  Time to Live: 64
  Protocol: UDP (17)
  Header Checksum: 0x30a3 [validation disabled]
  [Header checksum status: Unverified]
  Source Address: 8.8.8.8
  Destination Address: 10.0.2.15
  User Datagram Protocol, Src Port: 53, Dst Port: 52846
  Domain Name System (response)
    Transaction ID: 0x7b10
    Flags: 0x8180 Standard query response, No error
    Questions: 1
    Answer RRs: 1
    Authority RRs: 0
    Additional RRs: 1
    Queries
    Answers
    Additional records
    [Request In: 1]
    [Time: 0.084954315 seconds]
```

- a: source:8.8.8.8
destination:10.0.2.5
- b. Header length:20bytes
Total packet length:89
Yes,it's longer.
- c: 1 answer ,time-to-live values:300

3.TCP packet

3	0.001462691	10.0.2.15	140.117.13.241	TCP	74 47994 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM=1 TSval=632358430 TSecr=0 WS=128
4	0.084953807	140.117.13.241	10.0.2.15	TCP	60 443 → 47994 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460
5	0.119396654	10.0.2.15	140.117.13.241	TCP	54 47994 → 443 [ACK] Seq=1 Ack=1 Win=64240 Len=0

```

Transmission Control Protocol, Src Port: 47994, Dst Port: 443, Seq: 0, Len: 0
Source Port: 47994
Destination Port: 443
[Stream index: 0]
[Conversation completeness: Complete, WITH_DATA (31)]
[TCP Segment Len: 0]
Sequence Number: 0 (relative sequence number)
Sequence Number (raw): 1514017795
[Next Sequence Number: 1 (relative sequence number)]
Acknowledgment Number: 0
Acknowledgment number (raw): 0
1010 .... = Header Length: 40 bytes (10)
Flags: 0x002 (SYN)
Window: 64240
[Calculated window size: 64240]
Checksum: 0xa6a3 [unverified]
[Checksum Status: Unverified]
Urgent Pointer: 0
Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale
  TCP Option - Maximum segment size: 1460 bytes
  TCP Option - SACK permitted
  TCP Option - Timestamps: TSval 632358430, TSecr 0
  TCP Option - No-Operation (NOP)
  TCP Option - Window scale: 7 (multiply by 128)
[Timestamps]

```

- a. ephemeral port number: 47994
client and the well-known port number :443
- b. 0
- c. 0
- d. 64240
- e. 1460bytes
- f. 0x002

part2 Probing the Internet

```
cindy@cindy-VirtualBox:~$ ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_seq=1 ttl=115 time=98.4 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=115 time=10.4 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=115 time=57.7 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=115 time=44.5 ms
64 bytes from 8.8.8.8: icmp_seq=5 ttl=115 time=24.6 ms
64 bytes from 8.8.8.8: icmp_seq=6 ttl=115 time=8.57 ms
64 bytes from 8.8.8.8: icmp_seq=7 ttl=115 time=86.1 ms
64 bytes from 8.8.8.8: icmp_seq=8 ttl=115 time=8.10 ms
64 bytes from 8.8.8.8: icmp_seq=9 ttl=115 time=30.8 ms
64 bytes from 8.8.8.8: icmp_seq=10 ttl=115 time=10.0 ms
64 bytes from 8.8.8.8: icmp_seq=11 ttl=115 time=26.8 ms
64 bytes from 8.8.8.8: icmp_seq=12 ttl=115 time=22.8 ms
```

1. Ping Captured

(1)

1	0.000000000	10.0.2.15	8.8.8.8	ICMP	98 Echo (ping) request id=0x0001, seq=1/256, ttl=64 (reply in 2)
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a. Time-to-Live:64

```
Internet Protocol Version 4, Src: 10.0.2.15, Dst: 8.8.8.8
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
  Total Length: 84
  Identification: 0xbdee (48622)
  Flags: 0x40, Don't fragment
  ...0 0000 0000 0000 = Fragment Offset: 0
  Time to Live: 64
  Protocol: ICMP (1)
  Header Checksum: 0x609c [validation disabled]
  [Header checksum status: Unverified]
  Source Address: 10.0.2.15
  Destination Address: 8.8.8.8
```

b. 8(Echo request)

```
Internet Control Message Protocol
  Type: 8 (Echo (ping) request)
  Code: 0
  Checksum: 0x6482 [correct]
  [Checksum Status: Good]
  Identifier (BE): 1 (0x0001)
  Identifier (LE): 256 (0x0100)
  Sequence Number (BE): 1 (0x0001)
  Sequence Number (LE): 256 (0x0100)
  [Response frame: 2]
  Timestamp from icmp data: Sep 12, 2022 14:35:20.000000000 CST
  [Timestamp from icmp data (relative): 0.750348107 seconds]
  Data (48 bytes)
```

c. identifier:1

sequence number:1

(2)

a. 0(Echo reply)

```
Internet Control Message Protocol
  Type: 0 (Echo (ping) reply)
  Code: 0
  Checksum: 0x6c82 [correct]
  [Checksum Status: Good]
  Identifier (BE): 1 (0x0001)
  Identifier (LE): 256 (0x0100)
  Sequence Number (BE): 1 (0x0001)
  Sequence Number (LE): 256 (0x0100)
  [Request frame: 1]
  [Response time: 98.296 ms]
  Timestamp from icmp data: Sep 12, 2022 14:35:20.000000000 CST
  [Timestamp from icmp data (relative): 0.848644376 seconds]
  Data (48 bytes)
```

2. Traceroute Captured

```
cindy@cindy-VirtualBox:~$ sudo traceroute -q 1 -I 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 30 hops max, 60 byte packets
 1  _gateway (10.0.2.2)  1.469 ms
 2  192.168.77.101 (192.168.77.101)  19.860 ms
 3  192.168.77.254 (192.168.77.254)  19.457 ms
 4  140.117.162.254 (140.117.162.254)  19.189 ms
 5  10.10.129.254 (10.10.129.254)  18.948 ms
 6  140.117.232.85 (140.117.232.85)  18.709 ms
 7  140.117.232.33 (140.117.232.33)  18.448 ms
 8  202.169.174.161 (202.169.174.161)  18.105 ms
 9  72.14.202.60 (72.14.202.60)  17.851 ms
10  209.85.254.217 (209.85.254.217)  17.781 ms
11  142.251.226.171 (142.251.226.171)  17.541 ms
12  dns.google (8.8.8.8)  17.309 ms
```

(1)

```
Internet Protocol Version 4, Src: 10.0.2.15, Dst: 8.8.8.8
 0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
  Total Length: 60
  Identification: 0xd9b1 (55729)
  Flags: 0x00
  ...0 0000 0000 0000 = Fragment Offset: 0
  Time to Live: 1
  Protocol: ICMP (1)
  Header Checksum: 0xc3f1 [validation disabled]
  [Header checksum status: Unverified]
  Source Address: 10.0.2.15
  Destination Address: 8.8.8.8
```

a. source: 10.0.2.5

destination: 8.8.8.8

b. type: ICMP(1)

Time-to-Live: 1

```

Internet Control Message Protocol
Type: 8 (Echo (ping) request)
Code: 0
Checksum: 0x6c22 [correct]
[Checksum Status: Good]
Identifier (BE): 5719 (0x1657)
Identifier (LE): 22294 (0x5716)
Sequence Number (BE): 1 (0x0001)
Sequence Number (LE): 256 (0x0100)
▶ [No response seen]
▶ Data (32 bytes)

```

- c. type:8(Echo request)
 identifier:5716
 sequence number:1

(2)

```

4 0.000933957 10.0.2.2 10.0.2.15 ICMP 70 Time-to-live exceeded (Time to live exceeded in transit)

```

- a. source: 10.0.2.2
 destination:10.0.2.5

```

▼ Internet Protocol Version 4, Src: 10.0.2.2, Dst: 10.0.2.15
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  ▶ Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
    Total Length: 56
    Identification: 0x11d9 (4569)
  ▶ Flags: 0x00
    ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 255
    Protocol: ICMP (1)
    Header Checksum: 0x911b [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 10.0.2.2
    Destination Address: 10.0.2.15

```

- b. 11(Time-to-Live exceeded)

```

▼ Internet Control Message Protocol
  Type: 11 (Time-to-live exceeded)
  Code: 0 (Time to live exceeded in transit)
  Checksum: 0x6a85 [correct]
  [Checksum Status: Good]
  Unused: 00000000
  ▶ Internet Protocol Version 4, Src: 10.0.2.15, Dst: 8.8.8.8
  ▶ Internet Control Message Protocol

```

Part3 Measuring Network Bandwidth

1.

```
cindy@cindy-VirtualBox:~$ iperf3 -c 140.117.171.208 -t 10 -i 2
Connecting to host 140.117.171.208, port 5201
[ 4] local 10.0.2.15 port 56950 connected to 140.117.171.208 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr   Cwnd
[ 4]  0.00-2.00      sec    13.9 MBytes   58.0 Mbits/sec    0   68.4 KBytes
[ 4]  2.00-4.05      sec    19.8 MBytes   81.3 Mbits/sec    0   68.4 KBytes
[ 4]  4.05-6.00      sec    14.0 MBytes   59.8 Mbits/sec    0   68.4 KBytes
[ 4]  6.00-8.00      sec    24.3 MBytes  102 Mbits/sec    0   68.4 KBytes
[ 4]  8.00-10.00     sec    27.8 MBytes  116 Mbits/sec    0   68.4 KBytes
-----
[ ID] Interval           Transfer     Bandwidth       Retr
[ 4]  0.00-10.00     sec    99.7 MBytes   83.6 Mbits/sec    0
[ 4]  0.00-10.00     sec    98.2 MBytes   82.4 Mbits/sec    0
sender
receiver
iperf Done.
```

2. 同時時間間隔內傳輸量變少，傳輸速率變慢

```
cindy@cindy-VirtualBox:~$ iperf3 -c 140.117.171.208 -w 2000 -t 10 -i 2
Connecting to host 140.117.171.208, port 5201
[ 4] local 10.0.2.15 port 49450 connected to 140.117.171.208 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr   Cwnd
[ 4]  0.00-2.00      sec     1.32 MBytes   5.52 Mbits/sec    0   47.1 KBytes
[ 4]  2.00-4.00      sec     1.06 MBytes   4.44 Mbits/sec    0   49.9 KBytes
[ 4]  4.00-6.01      sec     2.08 MBytes   8.69 Mbits/sec    0   58.5 KBytes
[ 4]  6.01-8.01      sec     1.31 MBytes   5.50 Mbits/sec    0   64.2 KBytes
[ 4]  8.01-10.00     sec     1.89 MBytes   7.95 Mbits/sec    0   68.4 KBytes
-----
[ ID] Interval           Transfer     Bandwidth       Retr
[ 4]  0.00-10.00     sec     7.66 MBytes   6.42 Mbits/sec    0
[ 4]  0.00-10.00     sec     7.53 MBytes   6.31 Mbits/sec    0
sender
receiver
iperf Done.
```

3. -u 是指採用 UDP 協議

TCP 要進行確認，所以用 UDP 測速更準確

```
cindy@cindy-VirtualBox:~$ iperf3 -c 140.117.171.208 -u -t 10 -i 2
Connecting to host 140.117.171.208, port 5201
[ 4] local 10.0.2.15 port 33068 connected to 140.117.171.208 port 5201
[ ID] Interval           Transfer     Bandwidth       Total Datagrams
[ 4]  0.00-2.01      sec     256 KBytes    1.04 Mbits/sec    32
[ 4]  2.01-4.00      sec     256 KBytes    1.05 Mbits/sec    32
[ 4]  4.00-6.02      sec     264 KBytes    1.07 Mbits/sec    33
[ 4]  6.02-8.00      sec     248 KBytes    1.03 Mbits/sec    31
[ 4]  8.00-10.04     sec     264 KBytes    1.06 Mbits/sec    33
-----
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[ 4]  0.00-10.04     sec     1.26 MBytes    1.05 Mbits/sec   3631460.314 ms  0/160 (0%)
[ 4] Sent 160 datagrams
iperf Done.
```

4. lost rate: 4.6%

-b 是指使用者的 bandwidth，bandwidth 變大，total datagrams 變多

```

cindy@cindy-VirtualBox:~$ iperf3 -c 140.117.171.208 -u -t 10 -i 2 -b 512G
Connecting to host 140.117.171.208, port 5201
[ 4] local 10.0.2.15 port 59212 connected to 140.117.171.208 port 5201
[ ID] Interval           Transfer     Bandwidth       Total Datagrams
[ 4]  0.00-2.01   sec    4.75 MBytes  19.9 Mbits/sec   608
[ 4]  2.01-4.00   sec    5.67 MBytes  23.9 Mbits/sec   726
[ 4]  4.00-6.04   sec    832 KBytes   3.34 Mbits/sec   104
[ 4]  6.04-8.05   sec    704 KBytes   2.88 Mbits/sec    88
[ 4]  8.05-10.02  sec    616 KBytes   2.55 Mbits/sec    77
- - - - -
[ ID] Interval           Transfer     Bandwidth       Jitter          Lost/Total Datagrams
[ 4]  0.00-10.02  sec   12.5 MBytes  10.5 Mbits/sec   6.721 ms       74/1603 (4.6%)
[ 4] Sent 1603 datagrams

iperf Done.

```