

Network Systems - Quiz 3 : Kiran Jojare

1. Question 1

1.1: Without Fragmenting

Different IP fragments created will using command ping www.quora.com -l 2000 is as follows from Wireshark using 4 ICMP packets:

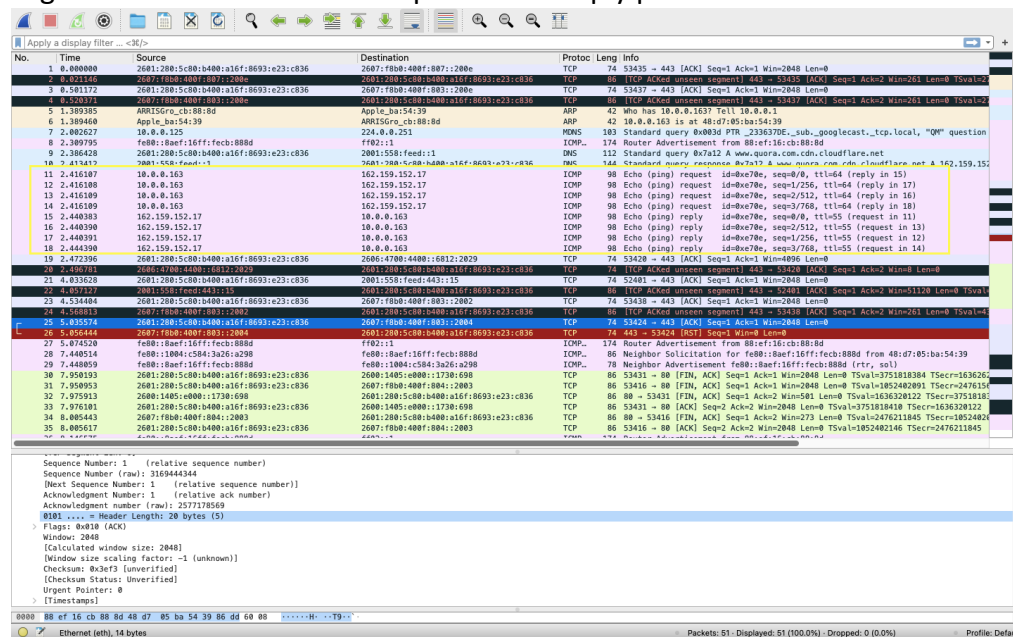
Terminal Window:

```
Last login: Sat Oct  8 23:57:38 on ttys000
[kiran@Kirans-MacBook-Air ~ %] su
[Password:
[sh-3.2# ping www.quora.com -l 1700 -c 4
PING www.quora.com.cdn.cloudflare.net (162.159.152.17): 56 data bytes
64 bytes from 162.159.152.17: icmp_seq=0 ttl=55 time=22.989 ms
64 bytes from 162.159.152.17: icmp_seq=1 ttl=55 time=32.239 ms
64 bytes from 162.159.152.17: icmp_seq=2 ttl=55 time=35.738 ms
64 bytes from 162.159.152.17: icmp_seq=3 ttl=55 time=35.752 ms

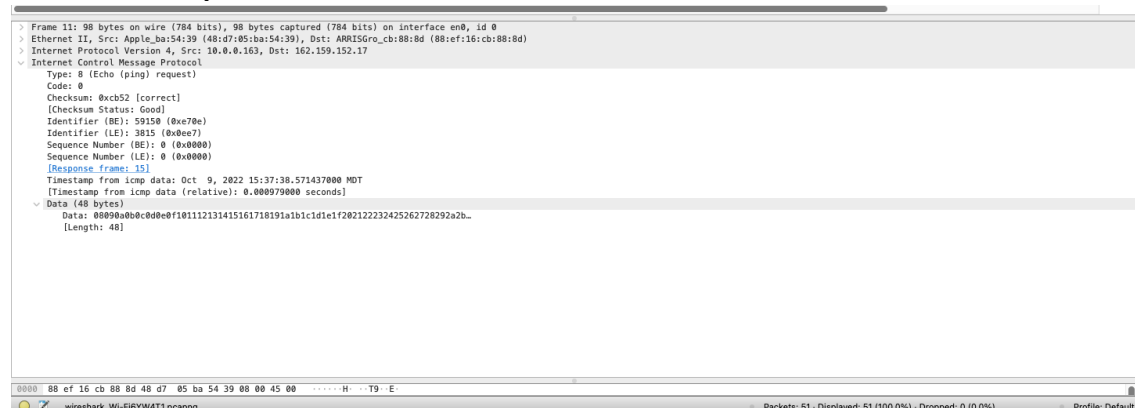
--- www.quora.com.cdn.cloudflare.net ping statistics ---
4 packets transmitted, 4 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 22.989/31.679/35.752/5.218 ms
sh-3.2#
```

Wireshark Window:

Figure below shows 4 echo request and 4 reply packets



ICMP Echo Request Packet



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ICMP Echo Reply Packet

> Frame 15: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface en0, id 0

> Ethernet II, Src: AR15Grcb:88:8d (88:ef:16:cb:88:8d), Dst: Apple_ba:54:39 (48:d7:85:ba:54:39)

> Internet Protocol Version 4, Src: 162.159.152.17, Dst: 10.0.0.163

> Internet Control Message Protocol

Type: 0 (Echo (ping) reply)

Code: 0

Checksum: 0xd352 [correct]

[Checksum Status: Good]

Identifier (BE): 59150 (0xe70e)

Identifier (LE): 3815 (0x0ee7)

Sequence Number (BE): 0 (0x0000)

Sequence Number (LE): 0 (0x0000)

[Request frame: 11]

[Response time: 24.276 ms]

Timestamp from icmp data: Oct 9, 2022 15:37:38.571437000 MDT

[Timestamp from icmp data (relative): 0.025255000 seconds]

> Data (48 bytes)

Data: 00090a0b0c0d0e0f101112131415161718191a1b1c1d1e1f202122232425262728292a2b...

[Length: 48]

0000 48 d7 05 ba 54 39 88 ef 16 cb 88 8d 08 00 45 00 H...T9...E

wireshark_Wi-Fi8Yw4T1.pcapng

Packets: 51 · Displayed: 51 (100.0%) · Dropped: 0 (0.0%)

Profile: Default

1.2 With Fragmenting

Terminal Window:

```
[sh-3.2# ping -l 50 www.quora.com -f -c 4
PING www.quora.com.cdn.cloudflare.net (162.159.153.247): 56 data bytes
...Request timeout for icmp_seq 2

--- www.quora.com.cdn.cloudflare.net ping statistics ---
4 packets transmitted, 1 packets received, 75.0% packet loss
round-trip min/avg/max/stddev = 25.560/25.560/25.560/0.000 ms
sh-3.2#
```

Wireshark Window:

Apply a display filter ...<3/>

No.	Time	Source	Destination	Protoc	Leng	Info
1	0.000000	10.0.0.163	224.0.0.251	MNMS	262	Standard query response 0x0000 TXT, cache flush NSEC, cache flush Kiran's MacBook Air,
2	0.000723	fe80::1804:c584:3a26:a298	:::1	MNMS	262	Standard query response 0x0000 TXT, cache flush NSEC, cache flush Kiran's MacBook Air,
3	1.897978	10.0.0.163	162.159.153.247	ICMP	98	Echo (ping) request id=0x4c0f, seq=0/0, ttl=64 (reply in 3)
4	1.897971	10.0.0.163	162.159.153.247	ICMP	98	Echo (ping) request id=0x4c0f, seq=1/256, ttl=64 (reply in 9)
5	1.897972	10.0.0.163	162.159.153.247	ICMP	98	Echo (ping) request id=0x4c0f, seq=2/512, ttl=64 (reply in 8)
6	1.897972	10.0.0.163	162.159.153.247	ICMP	98	Echo (ping) request id=0x4c0f, seq=3/768, ttl=64 (reply in 7)
7	1.121311	162.159.153.247	10.0.0.163	ICMP	98	Echo (ping) reply id=0x4c0f, seq=3/768, ttl=55 (request in 6)
8	1.121328	162.159.153.247	10.0.0.163	ICMP	98	Echo (ping) reply id=0x4c0f, seq=2/512, ttl=55 (request in 5)
9	1.121321	162.159.153.247	10.0.0.163	ICMP	98	Echo (ping) reply id=0x4c0f, seq=1/256, ttl=55 (request in 4)
10	1.121323	162.159.153.247	10.0.0.163	ICMP	98	Echo (ping) reply id=0x4c0f, seq=0/0, ttl=55 (request in 3)
11	4.244619	2601:2081:5c0:b400:a16f:b693:c23:c836	2601:558:feed:443::15	TCP	74	53487 → 443 [ACK] Seq=1 Ack=1 Win=2048 Len=0
12	9.244619	10.0.0.163	224.0.0.251	ICMP	98	Echo (ping) request id=0x4c0f, seq=0/0, ttl=64 (reply in 3)
13	4.401818	10.0.0.125	239.255.255.250	SSDP	167	M-SEARCH → HTTP/1.1
14	4.706853	fe80::8aef:16ff:feeb:888d	:::1	ICMP	174	Router Advertisement from 88:ef:16:cb:88:8d
15	5.015382	10.0.0.125	239.255.255.250	SSDP	167	M-SEARCH → HTTP/1.1
16	5.040717	10.0.0.125	239.255.255.250	SSDP	167	M-SEARCH → HTTP/1.1
17	9.299329	fe80::1804:c584:3a26:a298	fe80::8aef:16ff:feeb:888d	ICMP	86	Neighbor Solicitation for fe80::8aef:16ff:feeb:888d from 48:d7:85:ba:54:39
18	9.314075	fe80::8aef:16ff:feeb:888d	fe80::1804:c584:3a26:a298	ICMP	78	Neighbor Advertisement fe80::8aef:16ff:feeb:888d (rtr, sol)

> Frame 1: 262 bytes on wire (2096 bits), 262 bytes captured (2096 bits) on interface en0, id 0

> Ethernet II, Src: Apple_ba:54:39 (48:d7:85:ba:54:39), Dst: IPv4cast_fb (01:00:5e:00:00:fb)

> Internet Protocol Version 4, Src: 10.0.0.163, Dst: 224.0.0.251

> User Datagram Protocol, Src Port: 5353, Dst Port: 5353

> Multicast Domain Name System (response)

ICMP Echo Request Packet

> Frame 3: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface en0, id 0

> Ethernet II, Src: Apple_ba:54:39 (48:d7:85:ba:54:39), Dst: AR03Grcb:88:8d (88:ef:16:cb:88:8d)

> Internet Protocol Version 4, Src: 10.0.0.163, Dst: 162.159.153.247

> Internet Control Message Protocol

Type: 0 (Echo (ping) request)

Code: 0

Checksum: 0x5d63 [correct]

[Checksum Status: Good]

Identifier (BE): 19471 (0x4c0f)

Identifier (LE): 3916 (0x0f4c)

Sequence Number (BE): 0 (0x0000)

Sequence Number (LE): 0 (0x0000)

[Response frame: 10]

Timestamp from icmp data: Oct 9, 2022 16:02:01.637796000 MDT

[Timestamp from icmp data (relative): 0.001235000 seconds]

> Data (48 bytes)

Data: 00090a0b0c0d0e0f101112131415161718191a1b1c1d1e1f202122232425262728292a2b...

[Length: 48]

0000 88 ef 16 cb 88 8d 48 d7 05 ba 54 39 08 00 45 00H...T9...E

wireshark_Wi-FiBPR71.pcapng

Packets: 18 · Displayed: 18 (100.0%) · Dropped: 0 (0.0%)

Profile: Default

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ICMP Echo Replay Packet

The image shows a Wireshark packet capture of an ICMP Echo (ping) reply. The packet list on the left shows Frame 7: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface en0, id 0. The packet details pane shows the following structure:

- Ethernet II, Src: AAR15Gro_cb:88:8d (88:ef:16:cb:88:8d), Dst: Apple_ba:54:39 (48:d7:85:ba:54:39)
- Internet Protocol Version 4, Src: 162.159.153.247, Dst: 10.0.0.163
- Internet Control Message Protocol
 - Type: 0 (Echo (ping) reply)
 - Code: 0
 - Checksum: 0x64ee [correct]
 - [Checksum Status: Good]
 - Identifier (BE): 19471 (0x4c0f)
 - Identifier (LE): 3916 (0x0f4c)
 - Sequence Number (BE): 3 (0x0003)
 - Sequence Number (LE): 768 (0x0300)
 - [Request frame: 6]
 - [Response time: 23.339 ms]
 - Timestamp from icmp data: Oct 9, 2022 16:02:01.637910000 HDT
 - [Timestamp from icmp data (relative): 0.024462000 seconds]
- Data (48 bytes)
 - Data: 00090a0b0c0d0e0f101112131415161718191a1b1c1d1e1f202122232425262728292a2b...
 - [Length: 48]

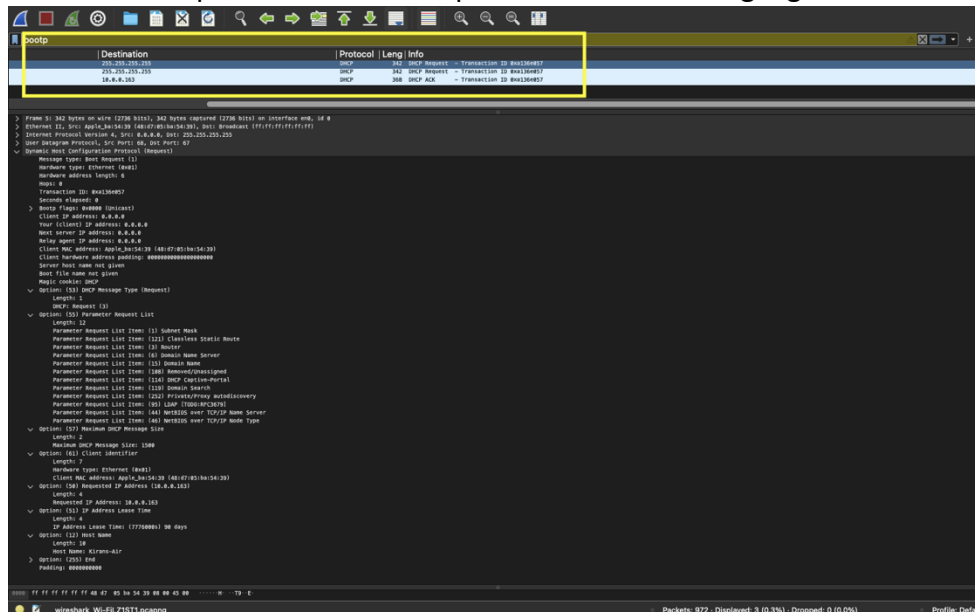
The packet bytes pane at the bottom shows the raw data: 48 d7 05 ba 54 39 88 ef 16 cb 88 8d 00 00 45 00 H...T9...E..

Wireshark interface: wireshark_Wi-FiBPR1.pcapng
Packets: 18 · Displayed: 18 (100.0%) · Dropped: 0 (0.0%)
Profile: Default

2. Question 2

2.1 DHCP DORA

Figure below shows the DCP DORA process used while pingng www.google.com from terminal. Two packets for DHCP Rqst and DHCP ACK is highlighted below:

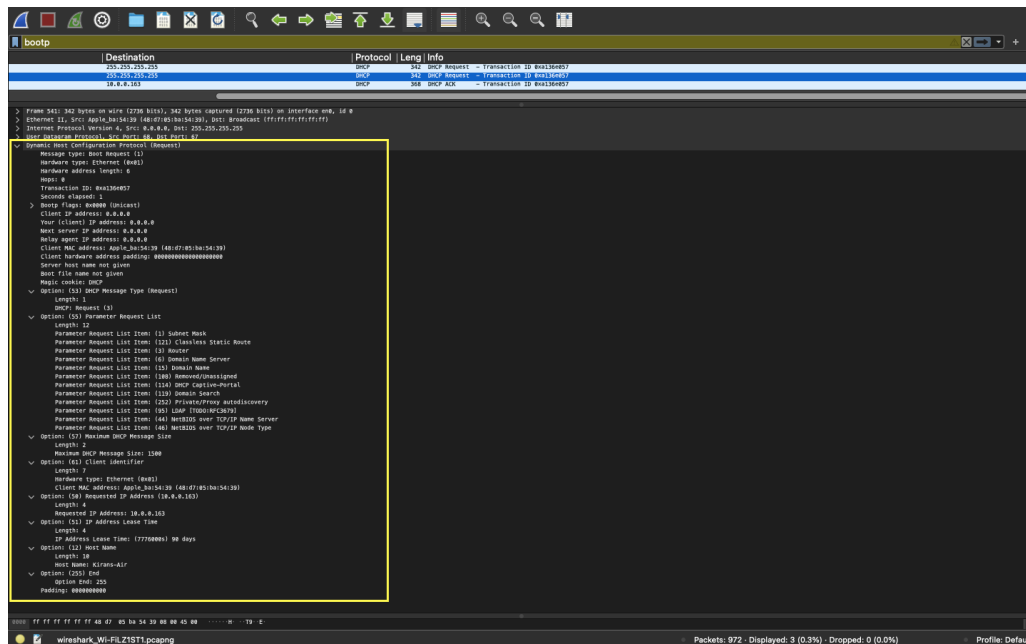


DHCP packets contains fields such as Hardware type, Message type, Hardware Address length, Hops, Opcode, Transaction ID's, Message Type, Options for Parameter Request List, Boot file name, Server Name and lastly IP and MAC addresses of client and server.

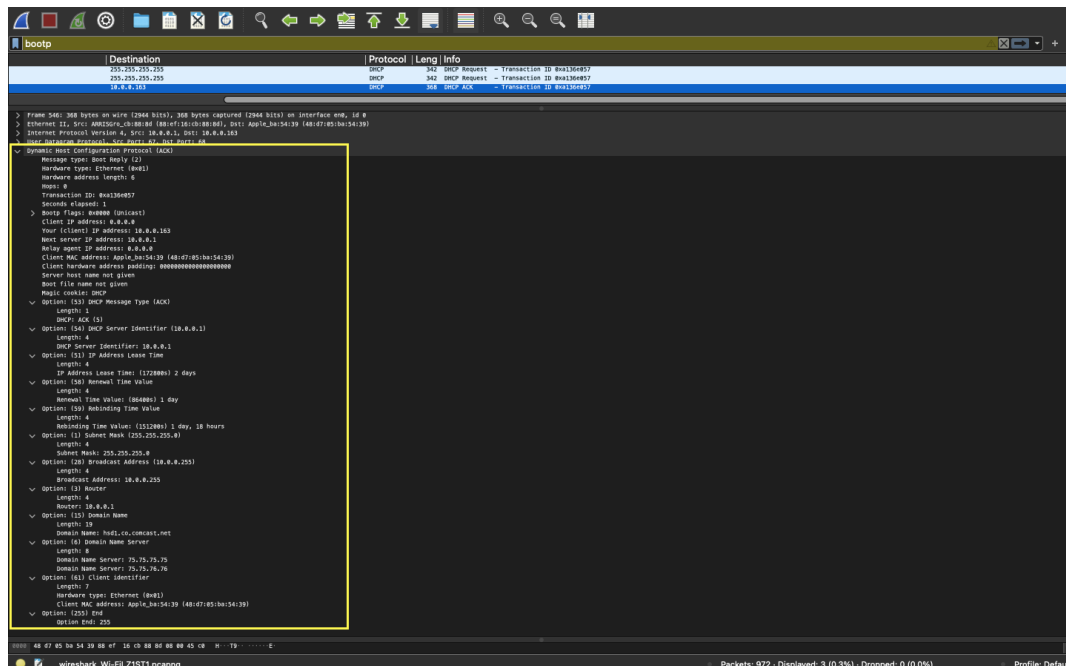
Hardware type defines type of DHCP packet response or request. Hardware address length field shows byte length of physical address. Hops fields highlights the hop in counts. Transaction ID is number used to identify DCHP DORA process info invokes by system. Flags field used as an indicator to indicate weather message is broadcast or unicast. Gateway IP indicates gateway IP address from LAN to local server. Client hardware field shows MAC address of the DHCP client. Options field which is a 8 to 214 bytes in length highlights DHCP message type. Two parameters inside options indicates type and length of data. DHCP packet header contains multiple fields for client and server IP and MAC addresses indication as well as gateway IP addresses too.

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DHCP Request Packet:



DHCP ACK Packet:



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2.2 ARP Request and Response:

The figure below shoes the ARP broadcast and ARP reply packets.

[illegible]

ARP packet contains fields as Hardware Type, prototype type, hardware length, protocol length, operation bit and sender and receiver address.

Hardware type field tells the local network type which is ethernet in this case. Protocol type defines type of protocol used. Hardware size reflects length of physical address in byte. Protocol length indicates length of IP address in bytes. Opcode defines ARP packet type which is 1 in case of Request and 2 in case of reply. MAC and IP address of sender & receiver are also highlighted in ARP packets.

ARP Broadcast Packet (ARP Request):

The image displays the Wireshark network protocol analyzer interface. The top section shows a packet capture list with one packet selected, an ARP request from Apple_Ba54:39 to the broadcast address. The middle section, 'Packet Details', shows the hierarchical structure of the packet: Ethernet II (Type: ARP), Internet Protocol (Destination: Broadcast), and ARP (Request). The bottom section, 'Packet Bytes', shows the raw data in hexadecimal and ASCII. A yellow box highlights the ARP request details in the packet details pane.

No.	Time	Source	Destination	Protocol	Length	Info
957	7.520625	Apple_Ba54:39	Broadcast	ARP	60	Request (hw type 1, hw len 6, op code 1)
958	7.520800	Apple_Ba54:39	Apple_Ba54:39	ARP	42	18.0.0.1 to et:08:00:00:00:00:00
957	7.521282	Apple_Ba54:39	Apple_Ba54:39	ARP	42	Who has 18.0.0.1? et:08:00:00:00:00:00
958	7.521245	Apple_Ba54:39	Apple_Ba54:39	ARP	42	18.0.0.1 to et:08:00:00:00:00:00
957	7.521375	Apple_Ba54:39	Apple_Ba54:39	ARP	42	18.0.0.1 to et:08:00:00:00:00:00
958	7.521445	Apple_Ba54:39	Apple_Ba54:39	ARP	42	18.0.0.1 to et:08:00:00:00:00:00

Packet Details:

- Ethernet II, Src: Apple_Ba54:39 (48:07:05:b4:54:39), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
 - Encapsulation type: Ethernet (1)
 - Arrival Time: Oct 8, 2022 19:45:08.438076000 MST
 - Time Shift for this packet: 8.400000000 seconds
 - Catch Time: 1665739908.438076000 seconds
 - Time Delta from previous captured frame: 8.127404000 seconds
 - Time Delta from previous displayed frame: 18.128118000 seconds
 - Time since reference or first frame: 17.340746000 seconds
 - Frame Number: 957
 - Frame Length: 42 bytes (336 bits)
 - Capture Length: 42 bytes (336 bits)
 - [Frame is marked: false]
 - [Frame is ignored: false]
 - [Protocols in frame: ethertypesystem]
 - Coloring Rule Name: ARP
 - Coloring Rule Settings: none
- Internet Protocol, Src: Apple_Ba54:39 (48:07:05:b4:54:39), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
 - Destination: Broadcast (ff:ff:ff:ff:ff:ff)
 - Address: Broadcast (ff:ff:ff:ff:ff:ff)
 - ...0... .. 00 bit: Locally administered address (this is NOT the factory default)
 - ...0... .. 00 bit: Group address (multicast/broadcast)
 - Source: Apple_Ba54:39 (48:07:05:b4:54:39)
 - Address: Apple_Ba54:39 (48:07:05:b4:54:39)
 - ...0... .. 00 bit: Globally unique address (factory default)
 - ...0... .. 00 bit: Individual address (unicast)
- Address Resolution Protocol (Request)
 - Hardware type: Ethernet (1)
 - Protocol type: IPv4 (0x0008)
 - Hardware size: 6
 - Protocol size: 4
 - OpCode: Request (1)
 - Sender Mac address: Apple_Ba54:39 (48:07:05:b4:54:39)
 - Sender IP address: 18.0.0.1
 - Target Mac address: 08:00:00:00:00:00 (08:00:00:00:00:00)
 - Target IP address: 18.0.0.1

Packet Bytes:

```

0000  ff ff ff ff ff ff ff ff 05 b4 54 39 00 00 00 01  ....
  
```

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ARP Reply Packet:

The image shows a Wireshark packet capture of an ARP Reply packet. The packet list at the top shows a packet from 10.0.0.1 to 10.0.0.1. The packet details pane shows the following information:

- Ethernet II, Src: Intel(R) Ethernet Controller (P0-P3), Dst: Apple_Bus54:39 (48:07:05:b4:54:39)
- Destination: Apple_Bus54:39 (48:07:05:b4:54:39)
- Source: Intel(R) Ethernet Controller (P0-P3) (82:00:14:00:00:00)
- Type: ARP (Request)
- Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.1
- Length: 28 (20 + 8)
- Protocol: ARP (Request)
- Operation: Reply (2)
- Sender MAC address: Intel(R) Ethernet Controller (P0-P3) (82:00:14:00:00:00)
- Sender IP address: 10.0.0.1
- Target MAC address: Apple_Bus54:39 (48:07:05:b4:54:39)
- Target IP address: 10.0.0.1

The packet bytes pane shows the raw data of the packet, which is a hexadecimal representation of the packet structure.

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2.3: DNS Query

No.	Time	Source	Destination	Protocol	Length	Info
495	1.793166	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	192	Standard query response 0xe4a1 AAAA us-central-courier-4.push-apple.com.
498	1.793164	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	188	Standard query response 0xa6a2 AAAA api.apple-cloudkit.fe.apple-dns.net.
499	1.793173	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	192	Standard query response 0x01dd HTTPS us-central-courier-4.push-apple.com.
500	1.793178	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	192	Standard query response 0xb670 AAAA us-sandbox-courier-4.push-apple.com.
649	2.174235	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	95	Standard query 0xa586 A doh.xfinity.com
650	2.174283	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	95	Standard query 0x2381 AAAA doh.xfinity.com
651	2.174643	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	95	Standard query 0x898f HTTPS doh.xfinity.com
654	2.197563	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	136	Standard query response 0xa586 A doh.xfinity.com CNAME doh2.gslb2.xfinity.com
655	2.197569	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	148	Standard query response 0x2381 AAAA doh.xfinity.com CNAME doh2.gslb2.xfinity.com
657	2.208401	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	205	Standard query response 0x898f HTTPS doh.xfinity.com CNAME doh2.gslb2.xfinity.com
658	2.208510	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	ICMP	253	Destination Unreachable (Port unreachable)
690	2.203546	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	93	Standard query 0xb3e5 AAAA ipv4only.arpa
691	2.205485	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	115	Standard query 0x4d88 PTR lb_dns-sd_udp.hsd1.co.comcast.net
692	2.483465	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	150	Standard query response 0xb3e5 AAAA ipv4only.arpa SOA sns.dns.icann.org
693	2.434385	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	167	Standard query response 0x4d88 No such name PTR lb_dns-sd_udp.hsd1.co.comcast.net
697	2.133111	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	93	Standard query 0xb3e5 AAAA ipv4only.arpa
702	2.143111	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	186	Standard query response 0x15ba A google.com A 142.250.72.78
707	2.176700	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	104	Standard query 0x42eb HTTPS gateway.fe.apple-dns.net
708	2.199095	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	177	Standard query response 0x45eb HTTPS gateway.fe.apple-dns.net SOA ns-287
784	5.676466	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	182	Standard query 0xd034 HTTPS gsp1-ssl.ls.apple.com
785	5.676559	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	182	Standard query 0x75ed AAAA gsp1-ssl.ls.apple.com
786	5.676613	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	182	Standard query 0x3bb3 A gsp1-ssl.ls.apple.com
787	5.702400	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	199	Standard query response 0xd3bb A gsp1-ssl.ls.apple.com CNAME gsp1-ssl
788	5.702414	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	241	Standard query response 0xd834 HTTPS gsp1-ssl.ls.apple.com CNAME gsp1-ssl
789	5.707725	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	241	Standard query response 0x75ed AAAA gsp1-ssl.ls.apple.com CNAME gsp1-ssl
790	5.708074	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	182	Standard query 0x70ba HTTPS e6987.a.akamaiedge.net
791	5.712114	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	182	Standard query 0x5a99 AAAA e6987.a.akamaiedge.net
797	6.751681	2601:280:5c00:b400:950a:220d:2bd2:4a13	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	183	Standard query response 0x74ba HTTPS e6987.a.akamaiedge.net CNAME gsp1-ssl

DNS packets contains fields such as ID, Query/Response Flags, Opcode, Answer/Authority/Additional RR's, Query and Response Fields.

DNS ID is usually created by server requesting query. Query Response flags distinguishes between the QR and also indicates bits for truncated and recursion message. Response codes (RR's) three reserved bits defined with value zero acting as a response for the server reply indicating if the query is answered correctly.

DNS Standard Query:

No.	Time	Source	Destination	Protocol	Length	Info
699	2.139711	2601:280:5c00:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	90	Standard query 0x15ba A google.com
702	2.143111	2001:558:feed::1	2601:280:5c00:b400:950a:220d:2bd2:4a13	DNS	186	Standard query response 0x15ba A google.com A 142.250.72.78

Domain Name System (query)
Transaction ID: 0x15ba
Flags: 0x0100 Standard query
. = Response Message is a query
. = Opcode: Standard query (0)
. = Truncated: Message is not truncated
. = Recursion desired: Do query recursively
. = Z: reserved (0)
. = Non-authenticated data: Unacceptable
Questions: 1
Answer RRs: 0
Authority RRs: 0
Additional RRs: 0
Queries
google.com: type A, class IN
Name: google.com
Name Length: 10
Label Count: 2
Type: A (Host Address) (1)
Class: IN (0x0001)
Response RRs: 0

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DNS Standard Response:

The image shows a Wireshark network packet capture of a DNS standard response. The packet list at the top shows two packets: a query (No. 699) and a response (No. 702). The response packet is selected, and its details are expanded in the main pane. A yellow box highlights the 'Domain Name System (response)' section, and a yellow arrow points to the 'Info' column of the response packet in the packet list.

Packet List:

No.	Time	Source	Destination	Protocol	Length	Info
699	2.830711	2601:280:5c80:b400:950a:220d:2bd2:4a13	2001:558:feed::1	DNS	90	Standard query 0x15ba A google.com
702	2.848810	2001:558:feed::1	2601:280:5c80:b400:950a:220d:2bd2:4a13	DNS	106	Standard query response 0x15ba A google.com A 142.250.72.78

Packet Details (Selected Packet: 702):

- Frame 702: 106 bytes on wire (848 bits), 106 bytes captured (848 bits) on interface en0, id 0
- Ethernet II, Src: ARRISGro_cb:88:8d (88:ef:16:cb:88:8d), Dst: Apple_ba:54:39 (48:d7:05:ba:54:39)
- Internet Protocol Version 6, Src: 2001:558:feed::1, Dst: 2601:280:5c80:b400:950a:220d:2bd2:4a13
- User Datagram Protocol, Src Port: 53, Dst Port: 54885
- Domain Name System (response)**
 - Transaction ID: 0x15ba
 - Flags: 0x8180 Standard query response, No error
 - .0000... = Response: Message is a response
 - ...0000... = Opcode: Standard query (0)
 - ...0... = Authoritative: Server is not an authority for domain
 - ...0... = Truncated: Message is not truncated
 - ...1... = Recursion desired: Do query recursively
 - ...1... = Recursion available: Server can do recursive queries
 - ...0... = Z: reserved (0)
 - ...0... = Answer authenticated: Answer/authority portion was not authenticated by the server
 - ...0... = Non-authenticated data: Unacceptable
 - ...0000... = Reply code: No error (0)
 - Questions: 1
 - Answer RRs: 1
 - Authority RRs: 0
 - Additional RRs: 0
 - Queries
 - google.com: type A, class IN
 - Name: google.com
 - [Name Length: 10]
 - [Label Count: 2]
 - Type: A (Host Address) (1)
 - Class: IN (0x0001)
 - Answers
 - google.com: type A, class IN, addr 142.250.72.78
 - Name: google.com
 - Type: A (Host Address) (1)
 - Class: IN (0x0001)
 - Time to live: 161 (2 minutes, 41 seconds)
 - Data length: 4
 - Address: 142.250.72.78
- [Request In: 699]
- [Time: 0.018099000 seconds]

Packet Bytes: 48 d7 05 ba 54 39 88 ef 16 cb 88 8d 86 dd 60 00 H...T9...

Status Bar: Domain Name System: Protocol Packets: 972 - Displayed: 243 (25.0%) - Dropped: 0 (0.0%) Profile: Default

Network Systems - Quiz 3 : Kiran Jojare

Question 3:

3.1 South Africa

The figure below shows that for website with.co.za domain (www.southafrica.co.za) it took 15 hops for system to route.

```
kiran@Kirans-MacBook-Air ~ % traceroute www.southafrica.co.za
traceroute to www.southafrica.co.za (64.225.13.78), 64 hops max, 52 byte packets
 1  10.0.0.1 (10.0.0.1)  8.961 ms  7.513 ms  6.459 ms
 2  100.92.104.131 (100.92.104.131)  27.390 ms
   100.92.104.130 (100.92.104.130)  23.791 ms
   100.92.104.131 (100.92.104.131)  27.455 ms
 3  24.124.157.253 (24.124.157.253)  21.937 ms
   96.216.160.21 (96.216.160.21)  23.524 ms
   24.124.157.253 (24.124.157.253)  19.781 ms
 4  162.151.8.93 (162.151.8.93)  21.843 ms
   162.151.80.57 (162.151.80.57)  21.351 ms
   162.151.8.93 (162.151.8.93)  21.836 ms
 5  96.216.147.73 (96.216.147.73)  21.030 ms
   162.151.80.57 (162.151.80.57)  25.346 ms
   96.216.147.73 (96.216.147.73)  24.346 ms
 6  96.216.147.73 (96.216.147.73)  27.233 ms
   ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  24.095 ms
   96.216.147.73 (96.216.147.73)  28.540 ms
 7  ae-13-edge8-denver1.level3.net (4.68.63.165)  32.308 ms
   ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  23.241 ms
   ae-13-edge8-denver1.level3.net (4.68.63.165)  25.149 ms
 8  ae-13-edge8-denver1.level3.net (4.68.63.165)  30.935 ms * 26.389 ms
   4.14.218.22 (4.14.218.22)  72.638 ms *
   4.14.218.30 (4.14.218.30)  86.067 ms
 9  4.14.218.30 (4.14.218.30)  74.991 ms *
   4.14.218.22 (4.14.218.22)  68.139 ms
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  unus.siyabona.com (64.225.13.78)  72.657 ms * 76.146 ms
kiran@Kirans-MacBook-Air ~ %
```

3.2: South America

The figure below shows that for website with. lat domain (www. Vbet.lat) it took 10 hops for system to route.

```
kiran@Kirans-MacBook-Air ~ % traceroute www.Vbet.lat
traceroute to www.vbet.lat (185.162.228.2), 64 hops max, 52 byte packets
 1  10.0.0.1 (10.0.0.1)  10.176 ms  6.176 ms  13.301 ms
 2  100.92.104.131 (100.92.104.131)  19.152 ms
   100.92.104.130 (100.92.104.130)  22.894 ms
   100.92.104.131 (100.92.104.131)  4.815 ms
 3  24.124.157.253 (24.124.157.253)  21.385 ms
   96.216.160.21 (96.216.160.21)  21.204 ms
   24.124.157.253 (24.124.157.253)  32.518 ms
 4  162.151.8.93 (162.151.8.93)  27.457 ms
   162.151.80.57 (162.151.80.57)  21.582 ms
   162.151.8.93 (162.151.8.93)  42.207 ms
 5  96.216.147.73 (96.216.147.73)  39.948 ms
   162.151.80.57 (162.151.80.57)  25.479 ms
   96.216.147.73 (96.216.147.73)  20.620 ms
 6  96.216.147.73 (96.216.147.73)  26.331 ms
   ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  52.476 ms
   96.216.147.73 (96.216.147.73)  38.444 ms
 7  be-36011-cs01.1601millehigh.co.ibone.comcast.net (96.110.43.241)  26.627 ms
   ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  38.888 ms
   be-36031-cs03.1601millehigh.co.ibone.comcast.net (96.110.43.249)  24.195 ms
 8  be-36041-cs04.1601millehigh.co.ibone.comcast.net (96.110.43.253)  27.573 ms
   be-3302-pe02.910fifteenth.co.ibone.comcast.net (96.110.38.122)  19.380 ms
   be-36021-cs02.1601millehigh.co.ibone.comcast.net (96.110.43.245)  43.161 ms
 9  50.208.232.118 (50.208.232.118)  31.292 ms
   be-0202-pe02.910fifteenth.co.ibone.comcast.net (96.110.38.118)  20.234 ms
   50.208.232.118 (50.208.232.118)  22.063 ms
10  50.208.232.118 (50.208.232.118)  21.017 ms
   185.162.228.2 (185.162.228.2)  25.111 ms
   50.208.232.118 (50.208.232.118)  20.038 ms
kiran@Kirans-MacBook-Air ~ %
```

Network Systems - Quiz 3 : Kiran Jojare

3.3: Australia

The figure below shows that for website with .au domain (www.australia.gov.au/) it took 21 hops for system to route.

```
kiran@Kirans-MacBook-Air ~ % traceroute www.australia.gov.au
traceroute Warning: www.australia.gov.au has multiple addresses; using 143.204.29.129
traceroute to ausgovcdn1.prod65.sa.smgovcloud.com.au (143.204.29.129), 64 hops max, 52 byte packets
 1  10.0.0.1 (10.0.0.1)  9.338 ms  4.065 ms  6.564 ms
 2  100.92.104.130 (100.92.104.130)  26.514 ms
   100.92.104.131 (100.92.104.131)  21.347 ms
   100.92.104.130 (100.92.104.130)  18.782 ms
 3  96.216.160.21 (96.216.160.21)  26.465 ms
   24.124.157.253 (24.124.157.253)  34.219 ms
   96.216.160.21 (96.216.160.21)  21.531 ms
 4  162.151.50.57 (162.151.50.57)  27.994 ms
   162.151.8.93 (162.151.8.93)  35.068 ms
   162.151.50.57 (162.151.50.57)  20.012 ms
 5  162.151.50.57 (162.151.50.57)  18.174 ms
   96.216.147.73 (96.216.147.73)  25.566 ms
   162.151.50.57 (162.151.50.57)  25.663 ms
 6  ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  25.835 ms
   96.216.147.73 (96.216.147.73)  19.965 ms
   ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  21.216 ms
 7  ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  24.474 ms
   be-36011-cr01.1601milehigh.co.ibone.comcast.net (96.110.43.241)  22.419 ms
   ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  27.189 ms
 8  * be-36011-cr01.1601milehigh.co.ibone.comcast.net (96.110.43.241)  30.841 ms
   be-1113-cr13.1601milehigh.co.ibone.comcast.net (96.110.39.110)  20.274 ms
 9  be-1413-cr13.1601milehigh.co.ibone.comcast.net (96.110.39.110)  26.664 ms
   be-304-cr14.champa.co.ibone.comcast.net (96.110.39.13)  19.867 ms *
10  be-1213-cr02.champa.co.ibone.comcast.net (96.110.37.229)  18.273 ms
   be-302-cr14.champa.co.ibone.comcast.net (96.110.39.5)  22.400 ms
   be-1114-cr01.champa.co.ibone.comcast.net (96.110.37.241)  40.488 ms
11  be-1213-cr02.champa.co.ibone.comcast.net (96.110.37.229)  18.604 ms
   be-3111-pe11.910fifteenth.co.ibone.comcast.net (96.110.33.114)  32.281 ms
   be-1313-cr03.champa.co.ibone.comcast.net (96.110.37.233)  27.132 ms
12  * be-3411-pe11.910fifteenth.co.ibone.comcast.net (96.110.33.126)  21.437 ms *
13  * 52.93.74.109 (52.93.74.109)  27.687 ms *
14  52.93.74.46 (52.93.74.46)  26.674 ms *
   52.93.74.63 (52.93.74.63)  22.893 ms *
15  52.93.74.64 (52.93.74.64)  30.733 ms
   52.93.74.231 (52.93.74.231)  20.288 ms *
16  * 52.93.74.231 (52.93.74.231)  24.068 ms *
17  * * *
18  * * *
19  * * *
20  * * *
21  * server-143-204-29-129.den50.r.cloudfront.net (143.204.29.129)  40.527 ms *
kiran@Kirans-MacBook-Air ~ %
```

3.4: Singapore

The figure below shows that for website with .sg domain (www.mfa.gov.sg) it took 16 hops for system to route.

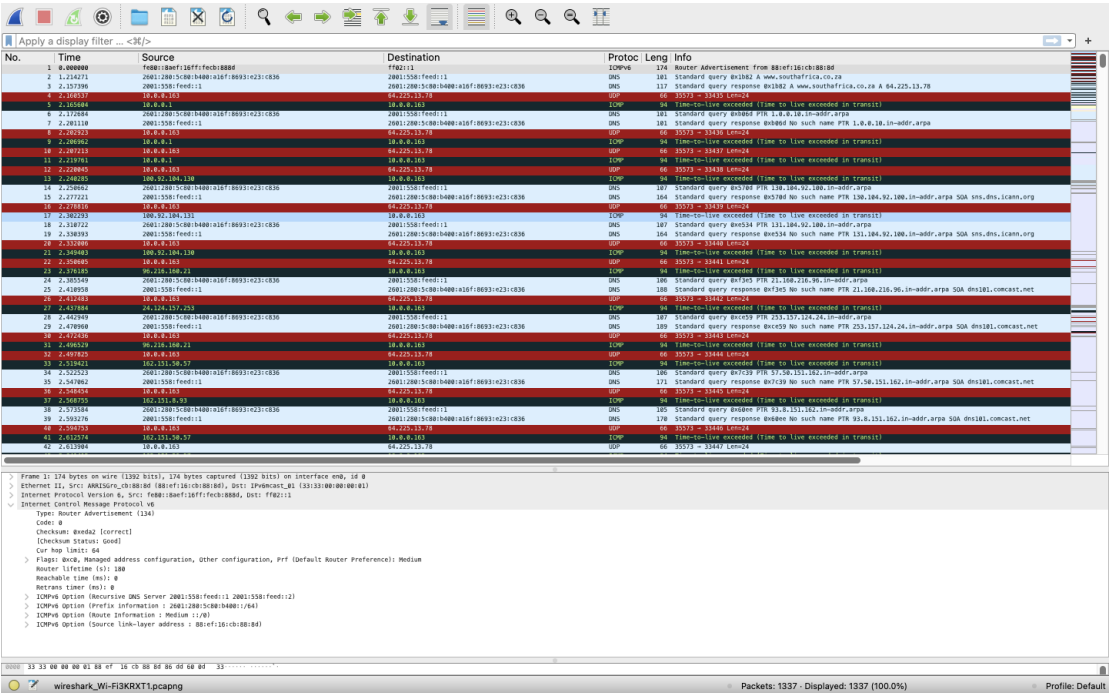
```
30 * * *
31 * * *
32 * * *
33 * * *
34 * * *
35 * * *
36 * * *
37 * * *
38 * * C
kiran@Kirans-MacBook-Air ~ % clear
kiran@Kirans-MacBook-Air ~ % traceroute www.mfa.gov.sg
traceroute Warning: www.mfa.gov.sg has multiple addresses; using 13.33.252.32
traceroute to d21t6tfdw4yiw.cloudfront.net (13.33.252.32), 64 hops max, 52 byte packets
 1  10.0.0.1 (10.0.0.1)  8.460 ms  5.522 ms  5.350 ms
 2  100.92.104.130 (100.92.104.130)  22.242 ms
   100.92.104.131 (100.92.104.131)  19.599 ms
   100.92.104.130 (100.92.104.130)  39.051 ms
 3  96.216.160.21 (96.216.160.21)  22.487 ms
   24.124.157.253 (24.124.157.253)  31.680 ms
   96.216.160.21 (96.216.160.21)  20.833 ms
 4  162.151.50.57 (162.151.50.57)  24.232 ms
   162.151.8.93 (162.151.8.93)  27.612 ms
   162.151.50.57 (162.151.50.57)  20.046 ms
 5  162.151.50.57 (162.151.50.57)  31.408 ms
   96.216.147.73 (96.216.147.73)  22.280 ms
   162.151.50.57 (162.151.50.57)  19.586 ms
 6  ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  21.984 ms
   96.216.147.73 (96.216.147.73)  19.528 ms
   ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  20.638 ms
 7  ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  28.432 ms
   be-36011-cr01.1601milehigh.co.ibone.comcast.net (96.110.43.241)  19.056 ms
   ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130)  23.249 ms
 8  be-1113-cr13.1601milehigh.co.ibone.comcast.net (96.110.39.110)  21.047 ms
   be-36041-cr04.1601milehigh.co.ibone.comcast.net (96.110.43.253)  20.598 ms
   be-1414-cr14.1601milehigh.co.ibone.comcast.net (96.110.39.126)  31.328 ms
 9  * be-1413-cr13.1601milehigh.co.ibone.comcast.net (96.110.39.110)  25.087 ms
10  be-1113-cr01.champa.co.ibone.comcast.net (96.110.37.225)  25.470 ms *
   be-1113-cr03.champa.co.ibone.comcast.net (96.110.37.233)  27.351 ms
11  be-1113-cr01.champa.co.ibone.comcast.net (96.110.37.225)  27.076 ms
   be-3212-pe12.910fifteenth.co.ibone.comcast.net (96.110.33.134)  24.619 ms
   be-1413-cr04.champa.co.ibone.comcast.net (96.110.37.237)  43.186 ms
12  * be-3111-pe11.910fifteenth.co.ibone.comcast.net (96.110.33.114)  23.099 ms *
13  * 52.93.74.45 (52.93.74.45)  22.830 ms *
14  52.93.74.164 (52.93.74.164)  19.636 ms *
   52.93.74.90 (52.93.74.90)  39.339 ms *
15  * 52.93.74.205 (52.93.74.205)  20.090 ms *
16  * 52.93.74.209 (52.93.74.209)  30.436 ms *
17  * * *
18  * * *
19  * * *
20  * * *
21  * server-13-33-252-32.den50.r.cloudfront.net (13.33.252.32)  30.412 ms *
kiran@Kirans-MacBook-Air ~ %
```

Question 4

Traceroute for the website www.southafrica.co.za :

```
sh-3.2# traceroute www.southafrica.co.za
traceroute to www.southafrica.co.za (64.225.13.78), 64 hops max, 52 byte packets
 1 10.0.0.1 (10.0.0.1) 7.350 ms 4.288 ms 12.795 ms
 2 100.92.104.130 (100.92.104.130) 21.139 ms
 3 100.92.104.131 (100.92.104.131) 24.441 ms
 4 100.92.104.130 (100.92.104.130) 17.623 ms
 5 96.216.168.21 (96.216.168.21) 26.543 ms
 6 24.124.157.253 (24.124.157.253) 26.358 ms
 7 96.216.168.21 (96.216.168.21) 24.351 ms
 8 162.151.58.57 (162.151.58.57) 22.277 ms
 9 162.151.8.93 (162.151.8.93) 21.271 ms
10 162.151.58.57 (162.151.58.57) 18.085 ms
11 162.151.58.57 (162.151.58.57) 27.767 ms
12 96.216.147.73 (96.216.147.73) 21.615 ms
13 162.151.58.57 (162.151.58.57) 22.436 ms
14 ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130) 27.317 ms
15 96.216.147.73 (96.216.147.73) 20.724 ms
16 ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130) 27.023 ms
17 ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130) 17.174 ms
18 ae-13-edge8.denver1.level3.net (4.68.63.165) 23.964 ms
19 ae-501-ar01.denver.co.denver.comcast.net (96.216.22.130) 22.981 ms
20 * ae-13-edge8.denver1.level3.net (4.68.63.165) 301.695 ms *
21 * 4.14.218.30 (4.14.218.30) 76.016 ms *
22 * 4.14.218.30 (4.14.218.30) 65.223 ms *
23 * *
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```

The Wireshark mapping with UDP and TCMP packets for each hop as shown below:



The table below shows the UDP frame data with TTL fields and port no used. The data field showed for each frame is a data of 24 bytes payload.

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[illegible]

5: Question 5

5.1: Using Century Link Looking Glass

5.1.1 Africa to Denver

From Johannesburg to CU Denver Public IP:

The data hoped from Johannesburg, New York, Denver and Back to CU Boulder.

JOHANNESBURG SOUTHAFRICA Traceroute results for: 128.138.0.0 (128.138.0.0)

```
Tracing route to 128.138.0.0 1 ae1.3511.edge2.NewYork6.level3.net (4.69.209.78) 250ms 251ms 253ms
 2 Lumen-level3-NewYork6.Level3.net (4.68.110.154) 250ms 250ms 253ms
 3 dvr-edge-13.inet.qwest.net (67.14.24.89) 287ms 286ms 286ms
 4 205.171.45.118 (205.171.45.118) 287ms 287ms 287ms
 5 compmx-tcommx-b.colorado.edu (128.138.81.221) 290ms 287ms 287ms
 6 0.0.0.0 (0.0.0.0) * * *
 7 0.0.0.0 (0.0.0.0) * * *
 8 0.0.0.0 (0.0.0.0) * * *
 9 0.0.0.0 (0.0.0.0) * * *
10 0.0.0.0 (0.0.0.0) * * *
11 0.0.0.0 (0.0.0.0) * * *
12 0.0.0.0 (0.0.0.0) * * *
13 0.0.0.0 (0.0.0.0) * * *
14 0.0.0.0 (0.0.0.0) * * *
15 0.0.0.0 (0.0.0.0) * * *
16 0.0.0.0 (0.0.0.0) * * *
17 0.0.0.0 (0.0.0.0) * * *
18 0.0.0.0 (0.0.0.0) * * *
19 0.0.0.0 (0.0.0.0) * * *
20 0.0.0.0 (0.0.0.0) * * *
21 0.0.0.0 (0.0.0.0) * * *
22 0.0.0.0 (0.0.0.0) * * *
23 0.0.0.0 (0.0.0.0) * * *
24 0.0.0.0 (0.0.0.0) * * *
25 0.0.0.0 (0.0.0.0) * * *
26 0.0.0.0 (0.0.0.0) * * *
27 0.0.0.0 (0.0.0.0) * * *
28 0.0.0.0 (0.0.0.0) * * *
29 0.0.0.0 (0.0.0.0) * * *
30 0.0.0.0 (0.0.0.0) * * *
```

5.1.2 South America to Denver

From Sao Paulo, Brazil to CU Denver Public IP:

The data hoped from Sao Paulo, New York, Denver and Back to CU Boulder.

SAOPAULO BRAZIL Traceroute results for: 128.138.0.0 (128.138.0.0)

```
Tracing route to 128.138.0.0 1 * * *
 2 ge-2-1-4.chi11.ip.tiscali.net (4.68.110.146) 107ms 109ms 107ms
 3 dvr-edge-13.inet.qwest.net (67.14.24.93) 155ms 150ms 152ms
 4 205.171.45.118 (205.171.45.118) 151ms 153ms 152ms
 5 compmx-tcommx-b.colorado.edu (128.138.81.221) 168ms 154ms 151ms
 6 * * *
 7 * * *
 8 * * *
 9 * * *
10 * * *
11 * * *
12 * * *
13 * * *
14 * * *
15 * * *
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
21 * * *
?? * * *
```

5.1.3 Australia to Denver

From Australia to CU Denver Public IP:

The data hoped from Sydney, Seattle, Denver and Back to CU Boulder.

Network Systems - Quiz 3 : Kiran Jojare

SYDNEY Traceroute results for: 128.138.0.0 (128.138.0.0)

```
Tracing route to 128.138.0.0 1 0.0.0.0 (0.0.0.0) * ae1.3502.ear3.Seattle1.level3.net (4.69.203.165) 173ms 173ms
2 Lumen-level3-Seattle1.Level3.net (4.68.110.174) 176ms 173ms 173ms
3 dvr-edge-13.inet.qwest.net (67.14.24.89) 200ms 200ms 201ms
4 205.171.45.118 (205.171.45.118) 201ms 201ms 201ms
5 compmx-tcommx-b.colorado.edu (128.138.81.221) 201ms 201ms 201ms
6 0.0.0.0 (0.0.0.0) * * *
7 0.0.0.0 (0.0.0.0) * * *
8 0.0.0.0 (0.0.0.0) * * *
9 0.0.0.0 (0.0.0.0) * * *
10 0.0.0.0 (0.0.0.0) * * *
11 0.0.0.0 (0.0.0.0) * * *
12 0.0.0.0 (0.0.0.0) * * *
13 0.0.0.0 (0.0.0.0) * * *
14 0.0.0.0 (0.0.0.0) * * *
15 0.0.0.0 (0.0.0.0) * * *
16 0.0.0.0 (0.0.0.0) * * *
17 0.0.0.0 (0.0.0.0) * * *
18 0.0.0.0 (0.0.0.0) * * *
19 0.0.0.0 (0.0.0.0) * * *
20 0.0.0.0 (0.0.0.0) * * *
21 0.0.0.0 (0.0.0.0) * * *
?? 0.0.0.0 (0.0.0.0) * * *
```

5.1.4 Singapore to Denver

From Singapore to CU Denver Public IP:

The data hoped from Singapore, Seattle, Denver and Back to CU Boulder.

SINGAPORE Traceroute results for: 128.138.0.0 (128.138.0.0)

```
Tracing route to 128.138.0.0 1 ae2.3602.ear3.Seattle1.level3.net (4.69.203.169) 158ms 158ms 0.0.0.0 (0.0.0.0) *
2 Lumen-level3-Seattle1.Level3.net (4.68.110.174) 153ms 153ms 158ms
3 dvr-edge-13.inet.qwest.net (67.14.24.89) 185ms 186ms 190ms
4 205.171.45.118 (205.171.45.118) 186ms 186ms 181ms
5 compmx-tcommx-b.colorado.edu (128.138.81.221) 191ms 186ms 186ms
6 0.0.0.0 (0.0.0.0) * * *
7 0.0.0.0 (0.0.0.0) * * *
8 0.0.0.0 (0.0.0.0) * * *
9 0.0.0.0 (0.0.0.0) * * *
10 0.0.0.0 (0.0.0.0) * * *
11 0.0.0.0 (0.0.0.0) * * *
12 0.0.0.0 (0.0.0.0) * * *
13 0.0.0.0 (0.0.0.0) * * *
14 0.0.0.0 (0.0.0.0) * * *
15 0.0.0.0 (0.0.0.0) * * *
16 0.0.0.0 (0.0.0.0) * * *
17 0.0.0.0 (0.0.0.0) * * *
18 0.0.0.0 (0.0.0.0) * * *
19 0.0.0.0 (0.0.0.0) * * *
20 0.0.0.0 (0.0.0.0) * * *
21 0.0.0.0 (0.0.0.0) * * *
?? 0.0.0.0 (0.0.0.0) * * *
```

5.2: Using Cogentco Looking Glass

5.2.1 Africa to Denver

From Johannesburg to CU Denver Public IP:

Data hopped from Johannesburg, London, New York, Chicago, Kansas and back to Denver as seen below.

```
traceroute to 128.138.0.0 (128.138.0.0), 30 hops max, 60 byte packets
 1  gi0-0-0-17.20.agr11.jnb01.atlas.cogentco.com (206.185.255.1)  0.860 ms  0.902 ms
 2  be2355.ccr51.jnb01.atlas.cogentco.com (154.54.43.37)  0.453 ms  0.608 ms
 3  be2385.ccr21.lon01.atlas.cogentco.com (154.54.40.93)  167.473 ms  167.500 ms
 4  ldn-b3-link.ip.twelve99.net (62.115.9.28)  175.473 ms  175.459 ms
 5  ldn-bb1-link.ip.twelve99.net (62.115.120.74)  193.591 ms  185.840 ms
 6  nyk-bb2-link.ip.twelve99.net (62.115.113.20)  247.507 ms nyk-bb1-link.ip.twelve99.net (62.115.112.244)  253.
 7  chi-b24-link.ip.twelve99.net (62.115.118.151)  253.220 ms  253.123 ms
 8  kanc-b2-link.ip.twelve99.net (62.115.125.153)  292.441 ms kanc-b2-link.ip.twelve99.net (213.155.130.177)  28
 9  kanc-bb2-link.ip.twelve99.net (62.115.138.74)  285.439 ms  272.566 ms
10  den-b3-link.ip.twelve99.net (62.115.139.205)  263.369 ms *
11  frontrange-ic328309-den-b1.ip.twelve99-cust.net (62.115.63.79)  303.176 ms  296.564 ms
12  core-1200-ptr.frgp.net (192.43.217.169)  276.917 ms  266.077 ms
13  ucb-il-frgp.colorado.edu (198.59.55.9)  264.843 ms  285.529 ms
14  * *
15  * *
16  * *
17  * *
18  * *
```

5.1.2 South America to Denver

From Sao Paulo, Brazil to CU Denver Public IP:

The data hopped from Sao Paulo, New York, Denver and Back to CU Boulder.

```
traceroute to 128.138.0.0 (128.138.0.0), 30 hops max, 60 byte packets
 1  gi100-0-0-43.51.ccr31.sao01.atlas.cogentco.com (209.14.255.1)  0.741 ms  0.785 ms
 2  be2531.ccr31.jfk10.atlas.cogentco.com (154.54.88.1)  109.880 ms  110.772 ms
 3  be2073.ccr31.jfk05.atlas.cogentco.com (154.54.0.229)  109.208 ms  109.300 ms
 4  ae-24.edge2.NewYork6.Level3.net (4.68.110.89)  109.697 ms  109.687 ms
 5  Lumen-level3-NewYork6.Level3.net (4.68.110.154)  108.706 ms  109.669 ms
 6  dvr-edge-13.inet.qwest.net (67.14.24.89)  149.770 ms  149.759 ms
 7  205.171.45.118 (205.171.45.118)  150.023 ms  151.028 ms
 8  compmx-tcommx-b.colorado.edu (128.138.81.221)  149.181 ms  150.155 ms
 9  * *
10  * *
11  * *
12  * *
13  * *
14  * *
15  * *
16  * *
17  * *
18  * *
```

5.2.3 Australia to Denver

From Sydney, Australia to CU Denver Public IP:

The data hopped from Sydney, Portland, Seattle, San Jose, Denver and Back to CU Boulder.

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```
traceroute to 128.138.0.0 (128.138.0.0), 30 hops max, 60 byte packets
 1  te0-3-1-17.32.ccr51.syd01.atlas.cogentco.com (206.149.255.1)  0.478 ms  0.477 ms
 2  be2237.ccr51.pdx02.atlas.cogentco.com (154.54.45.121)  133.585 ms  133.574 ms
 3  be2216.ccr21.pdx01.atlas.cogentco.com (154.54.31.157)  134.188 ms  134.125 ms
 4  be2670.ccr22.sea02.atlas.cogentco.com (154.54.42.149)  137.373 ms  137.710 ms
 5  sea-b2-link.telia.net (62.115.187.136)  137.302 ms  137.252 ms
 6  sjo-b23-link.ip.twelve99.net (62.115.118.169)  154.660 ms  154.527 ms
 7  den-b1-link.ip.twelve99.net (213.155.133.170)  175.913 ms  175.870 ms
 8  den-b3-link.ip.twelve99.net (62.115.139.248)  173.729 ms  173.581 ms
 9  frontrange-ic328309-den-b1.ip.twelve99-cust.net (62.115.63.79)  175.764 ms  173.686 ms
10  core-1200-ptr.frgp.net (192.43.217.169)  175.461 ms  173.553 ms
11  ucb-i1-frgp.colorado.edu (198.59.55.9)  176.402 ms  176.525 ms
12  * *
13  * *
14  * *
15  * *
16  * *
17  * *
18  * *
```

5.2.4 Singapore to Denver

From Singapore to CU Denver Public IP:

The data hoped from Singapore, Los Angeles, San Jose, San Francisco, Seattle, San Jose, Denver and Back to CU Boulder.

```
traceroute to 128.138.0.0 (128.138.0.0), 30 hops max, 60 byte packets
 1  gi0-0-0-19.215.nr11.b019922-0.sin01.atlas.cogentco.com (66.250.250.201)  1.012 ms  0.995 ms
 2  te0-0-0-33.nr01.b019922-0.sin01.atlas.cogentco.com (154.24.75.133)  1.286 ms te0-0-0-19.nr01.b019922-0.sin01
 3  te0-0-0-23.agr02.sin01.atlas.cogentco.com (154.24.61.77)  1.501 ms te0-0-0-23.agr01.sin01.atlas.cogentco.com
 4  be2080.ccr31.sin01.atlas.cogentco.com (154.54.88.17)  1.394 ms  1.458 ms
 5  be2913.ccr41.lax04.atlas.cogentco.com (154.54.27.54)  202.533 ms  202.532 ms
 6  be3271.ccr41.lax01.atlas.cogentco.com (154.54.42.101)  210.028 ms be3360.ccr42.lax01.atlas.cogentco.com (154
 7  be3176.ccr21.sjc01.atlas.cogentco.com (154.54.31.190)  198.411 ms be3177.ccr22.sjc01.atlas.cogentco.com (154
 8  be3179.ccr22.sfo01.atlas.cogentco.com (154.54.43.149)  198.146 ms be3178.ccr21.sfo01.atlas.cogentco.com (154
 9  be2077.ccr22.sea02.atlas.cogentco.com (154.54.0.242)  209.607 ms  202.007 ms
10  sea-b2-link.telia.net (62.115.187.136)  209.217 ms  223.381 ms
11  sjo-b23-link.ip.twelve99.net (62.115.118.169)  203.881 ms  204.352 ms
12  den-b1-link.ip.twelve99.net (213.155.133.170)  230.473 ms  224.686 ms
13  den-b3-link.ip.twelve99.net (62.115.139.248)  221.890 ms  221.824 ms
14  frontrange-ic328309-den-b1.ip.twelve99-cust.net (62.115.63.79)  227.303 ms  230.066 ms
15  core-1200-ptr.frgp.net (192.43.217.169)  233.698 ms  231.750 ms
16  ucb-i1-frgp.colorado.edu (198.59.55.9)  235.080 ms  231.052 ms
17  * *
18  * *
```