NETWORKING TRAINING - MODULE 7 & 8

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Qn 1:

Try Test-Connection and nslookup commands for below websites www.google.com, www.facebook.com www.amazon.com, www.github.com, www.cisco.com

nslookup:

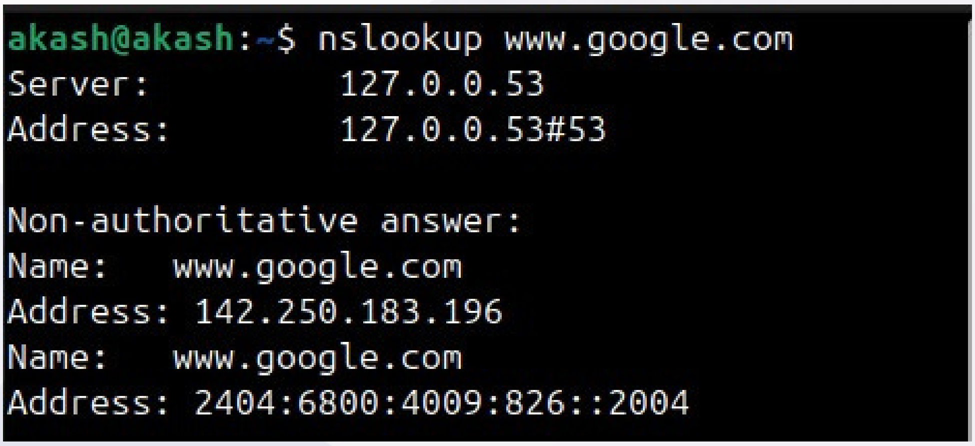
- nslookup - **Name Server Lookup**
- It is a command-line tool used to query Domain Name System (DNS) servers to obtain domain name or IP address mappings.

What does nslookup do?

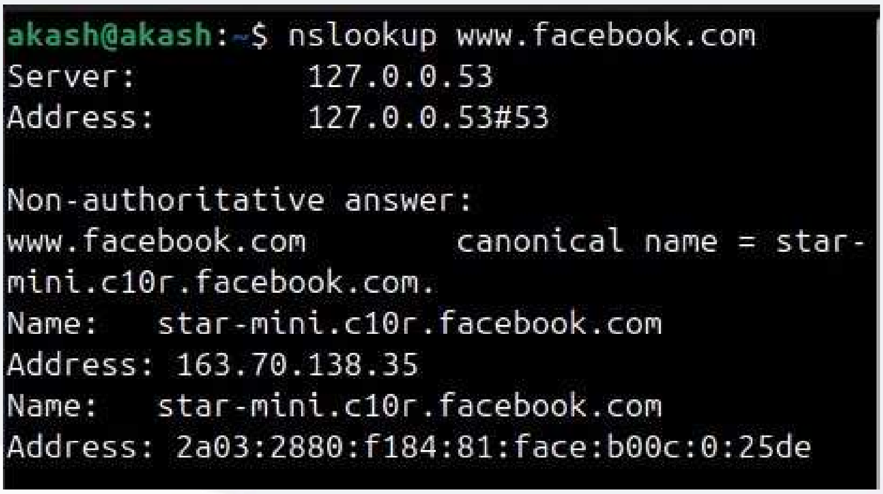
- Resolves a domain name to its corresponding IP address.
- Queries specific DNS servers for domain information.
- We can diagnose DNS related network issues.

How it works?

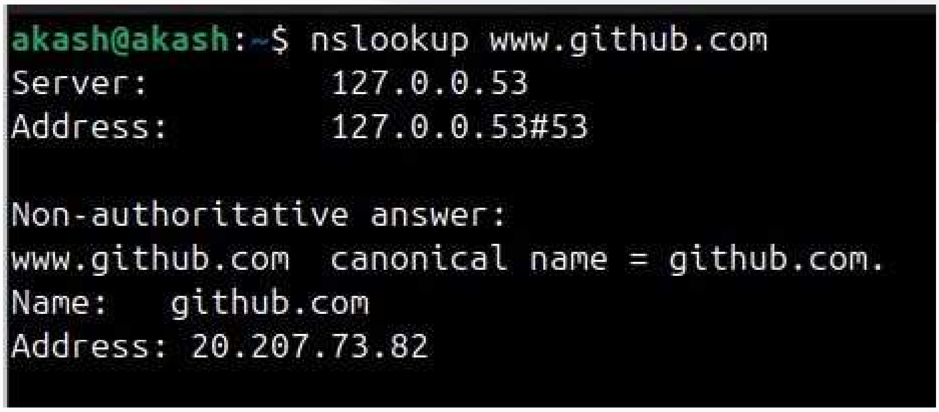
- When we type a domain name, nslookup contacts the system's DNS resolver.
- DNS resolver queries appropriate DNS server to get IP address
- If the queried server is non-authoritative, it forwards the request to the authoritative DNS server.
- Finally the domain name and its mapped IP is shown



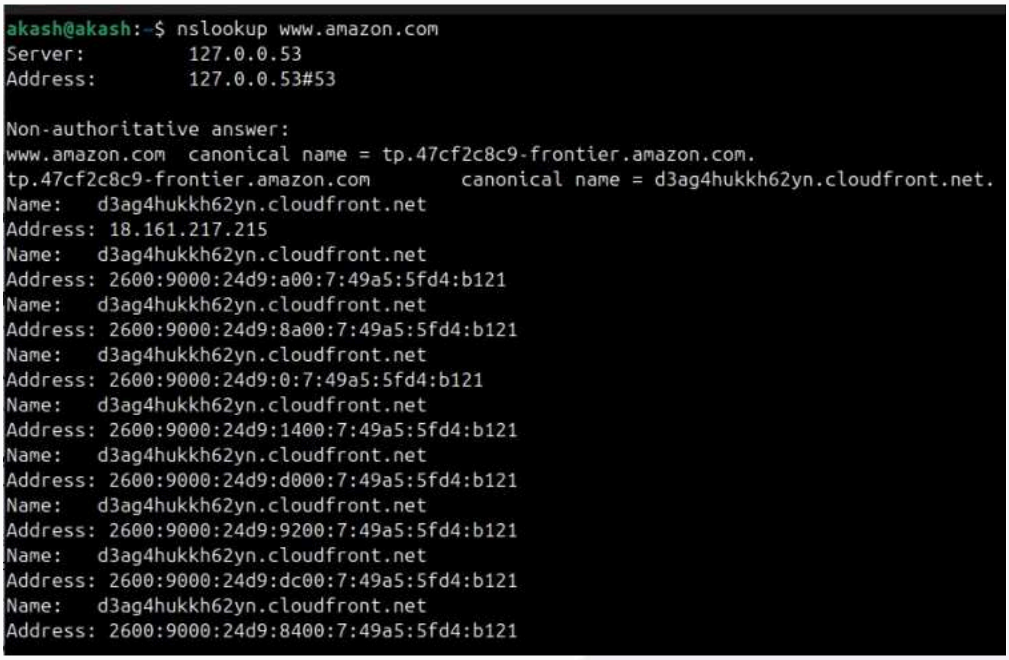
```
akash@akash:~$ nslookup www.google.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
Name:   www.google.com
Address: 142.250.183.196
Name:   www.google.com
Address: 2404:6800:4009:826::2004
```



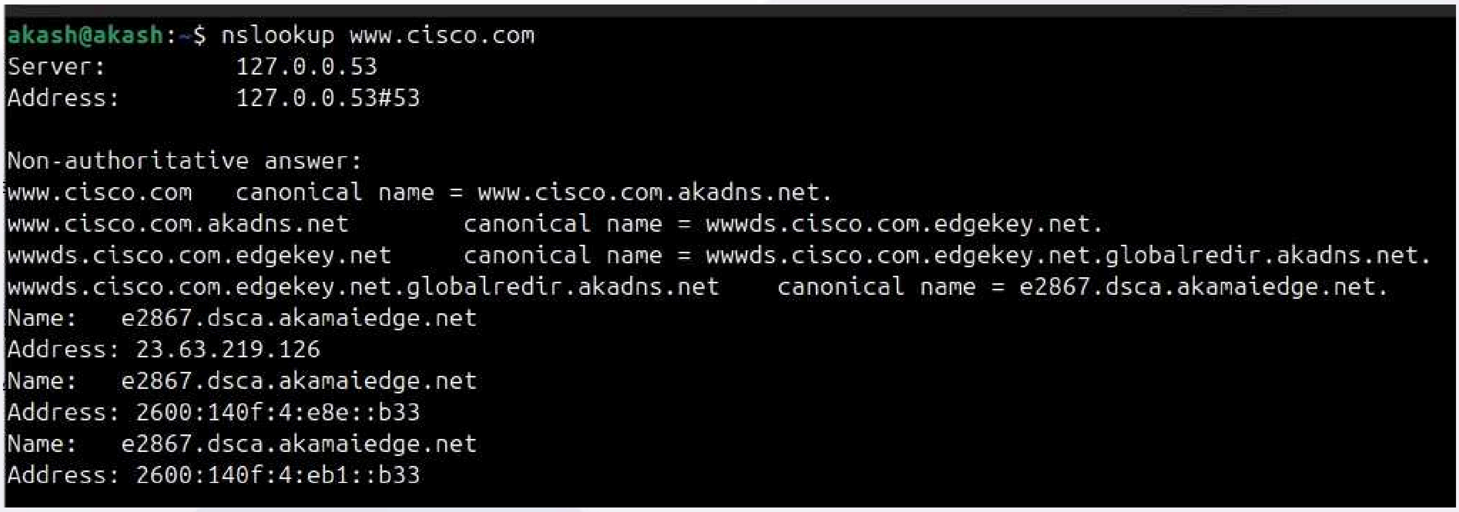
```
akash@akash:~$ nslookup www.facebook.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
www.facebook.com        canonical name = star-
mini.c10r.facebook.com.
Name:   star-mini.c10r.facebook.com
Address: 163.70.138.35
Name:   star-mini.c10r.facebook.com
Address: 2a03:2880:f184:81:face:b00c:0:25de
```



```
akash@akash:~$ nslookup www.github.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
www.github.com  canonical name = github.com.
Name:   github.com
Address: 20.207.73.82
```



```
akash@akash:~$ nslookup www.amazon.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
www.amazon.com  canonical name = tp.47cf2c8c9-frontier.amazon.com.
tp.47cf2c8c9-frontier.amazon.com        canonical name = d3ag4hukkh62yn.cloudfront.net.
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 18.161.217.215
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 2600:9000:24d9:a00:7:49a5:5fd4:b121
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 2600:9000:24d9:8a00:7:49a5:5fd4:b121
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 2600:9000:24d9:0:7:49a5:5fd4:b121
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 2600:9000:24d9:1400:7:49a5:5fd4:b121
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 2600:9000:24d9:d000:7:49a5:5fd4:b121
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 2600:9000:24d9:9200:7:49a5:5fd4:b121
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 2600:9000:24d9:dc00:7:49a5:5fd4:b121
Name:   d3ag4hukkh62yn.cloudfront.net
Address: 2600:9000:24d9:8400:7:49a5:5fd4:b121
```



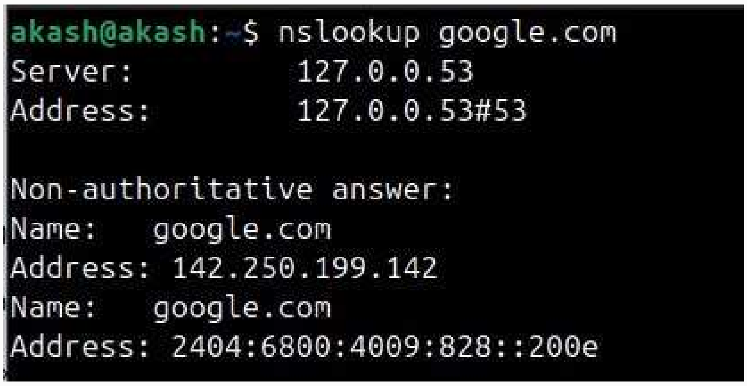
```
akash@akash:~$ nslookup www.cisco.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
www.cisco.com   canonical name = www.cisco.com.akadns.net.
www.cisco.com.akadns.net        canonical name = wwwds.cisco.com.edgekey.net.
wwwds.cisco.com.edgekey.net     canonical name = wwwds.cisco.com.edgekey.net.globalredir.akadns.net.
wwwds.cisco.com.edgekey.net.globalredir.akadns.net    canonical name = e2867.dsca.akamaiedge.net.
Name:   e2867.dsca.akamaiedge.net
Address: 23.63.219.126
Name:   e2867.dsca.akamaiedge.net
Address: 2600:140f:4:e8e::b33
Name:   e2867.dsca.akamaiedge.net
Address: 2600:140f:4:eb1::b33
```

Qn 2:

. Use Wireshark to capture and analyze DNS, TCP, UDP traffic and packet header, packet flow, options and flags

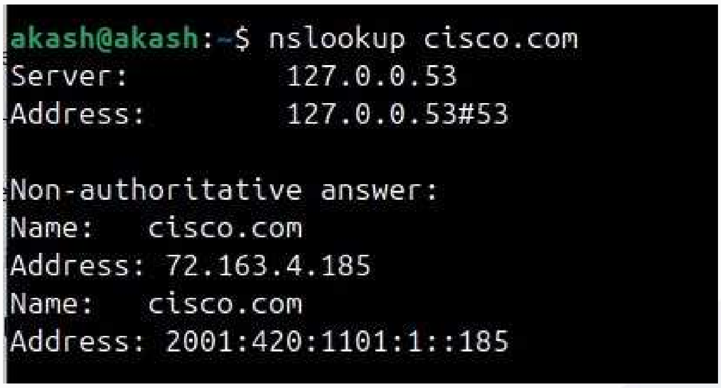
1 Capturing DNS Traffic:

- By running this command, we can capture DNS traffic
  - nslookup embedur.ai
- In wireshark, we can filter the traffic with the keyword “**dns**”



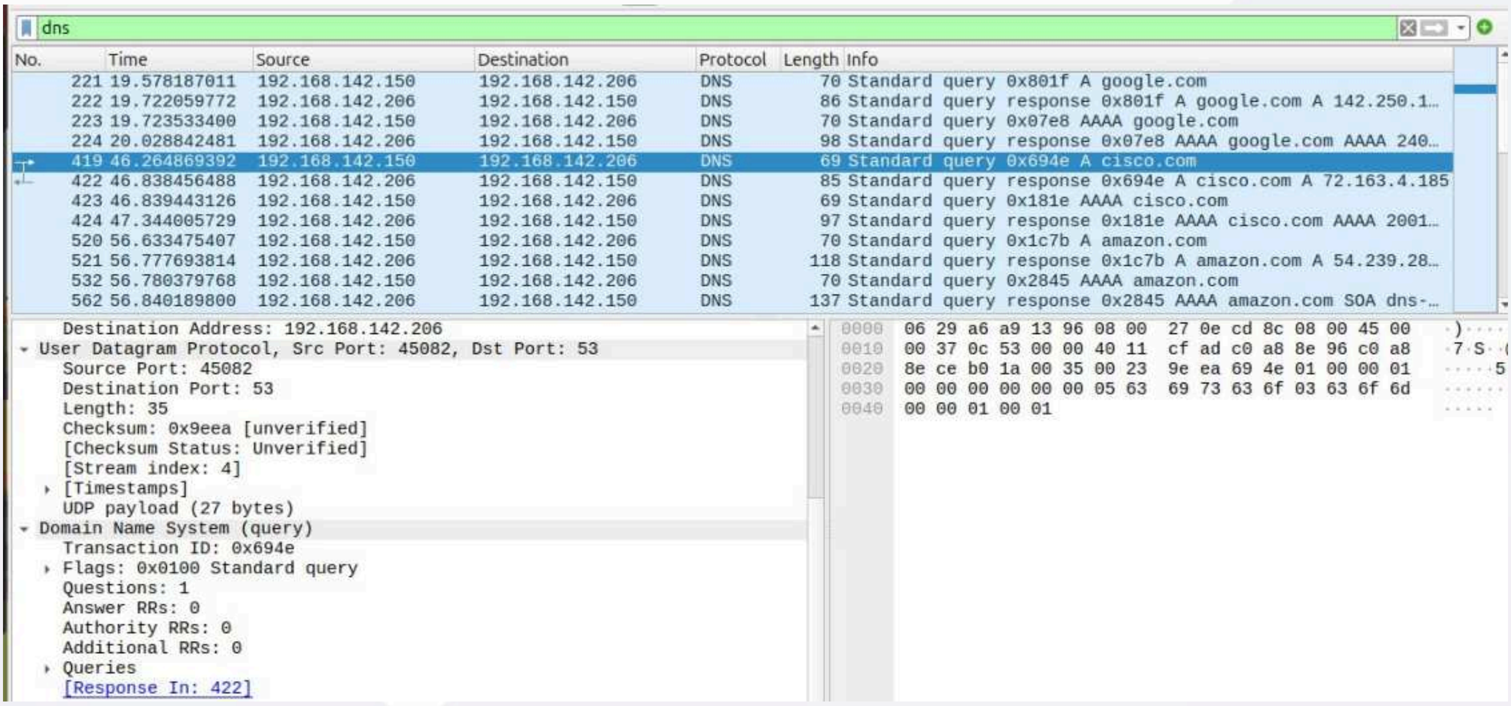
```
akash@akash:~$ nslookup google.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
Name:   google.com
Address: 142.250.199.142
Name:   google.com
Address: 2404:6800:4009:828::200e
```

google.com



```
akash@akash:~$ nslookup cisco.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
Name:   cisco.com
Address: 72.163.4.185
Name:   cisco.com
Address: 2001:420:1101:1::185
```

cisco.com



```
dns
No.     Time          Source           Destination      Protocol Length Info
    221 19.578187011  192.168.142.150  192.168.142.206  DNS        70 Standard query 0x801f A google.com
    222 19.722059772  192.168.142.206  192.168.142.150  DNS        86 Standard query response 0x801f A google.com A 142.250.1…
    223 19.723533400  192.168.142.150  192.168.142.206  DNS        70 Standard query 0x07e8 AAAA google.com
    224 20.028842481  192.168.142.206  192.168.142.150  DNS        98 Standard query response 0x07e8 AAAA google.com AAAA 240…
    419 46.264869392  192.168.142.150  192.168.142.206  DNS        69 Standard query 0x694e A cisco.com
    422 46.838456488  192.168.142.206  192.168.142.150  DNS        85 Standard query response 0x694e A cisco.com A 72.163.4.185
    423 46.839443126  192.168.142.150  192.168.142.206  DNS        69 Standard query 0x181e AAAA cisco.com
    424 47.344005729  192.168.142.206  192.168.142.150  DNS        97 Standard query response 0x181e AAAA cisco.com AAAA 2001…
    520 56.633475407  192.168.142.150  192.168.142.206  DNS        70 Standard query 0x1c7b A amazon.com
    521 56.777693814  192.168.142.206  192.168.142.150  DNS       118 Standard query response 0x1c7b A amazon.com A 54.239.28…
    532 56.780379768  192.168.142.150  192.168.142.206  DNS        70 Standard query 0x2845 AAAA amazon.com
    562 56.840189800  192.168.142.206  192.168.142.150  DNS       137 Standard query response 0x2845 AAAA amazon.com SOA dns-…
```

```
    Destination Address: 192.168.142.206
▾ User Datagram Protocol, Src Port: 45082, Dst Port: 53
    Source Port: 45082
    Destination Port: 53
    Length: 35
    Checksum: 0x9eea [unverified]
    [Checksum Status: Unverified]
    [Stream index: 4]
  ▸ [Timestamps]
    UDP payload (27 bytes)
▾ Domain Name System (query)
    Transaction ID: 0x694e
  ▸ Flags: 0x0100 Standard query
    Questions: 1
    Answer RRs: 0
    Authority RRs: 0
    Additional RRs: 0
  ▸ Queries
    [Response In: 422]
```

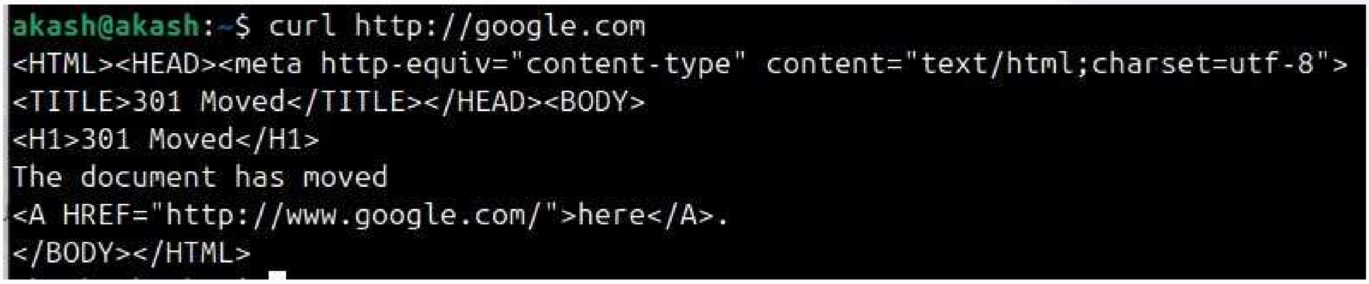
```
0000  06 29 a6 a9 13 96 08 00  27 0e cd 8c 08 00 45 00   ·)····
0010  00 37 0c 53 00 00 40 11  cf ad c0 a8 8e 96 c0 a8   ·7·S··(
0020  8e ce b0 1a 00 35 00 23  9e ea 69 4e 01 00 00 01   ·····5
0030  00 00 00 00 00 00 05 63  69 73 63 6f 03 63 6f 6d   ······
0040  00 00 01 00 01                                     ·····
```

dns traffic in wireshark

Capturing TCP Traffic:

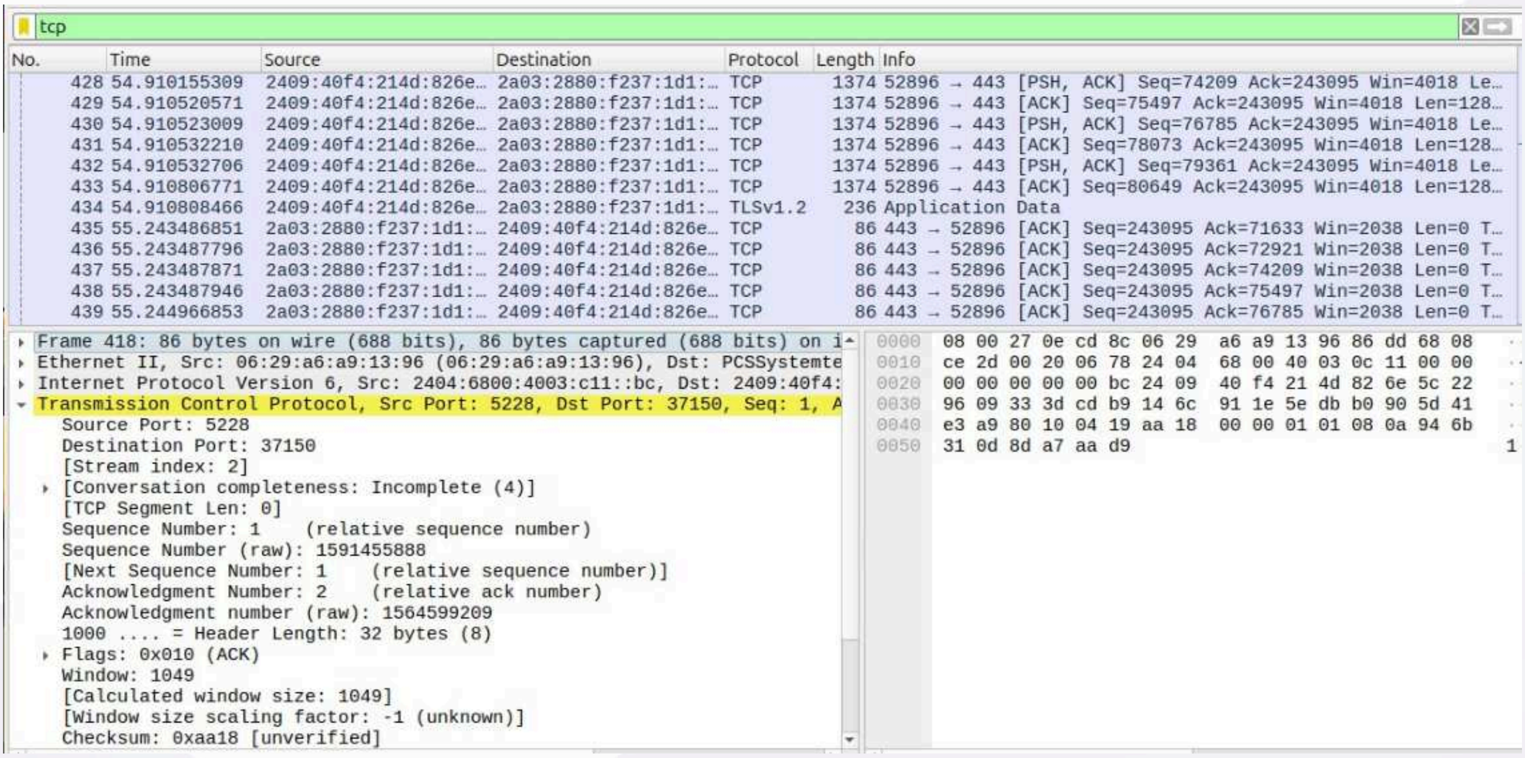
2

- By running this command, we can capture TCP traffic
    - **curl http://embedur.ai**
- We can also capture tcp traffic by running any website in the machine
- In wireshark, we can filter the traffic with the keyword **“tcp”**



```
akash@akash:~$ curl http://google.com
<HTML><HEAD><meta http-equiv="content-type" content="text/html;charset=utf-8">
<TITLE>301 Moved</TITLE></HEAD><BODY>
<H1>301 Moved</H1>
The document has moved
<A HREF="http://www.google.com/">here</A>.
</BODY></HTML>
```

curl command



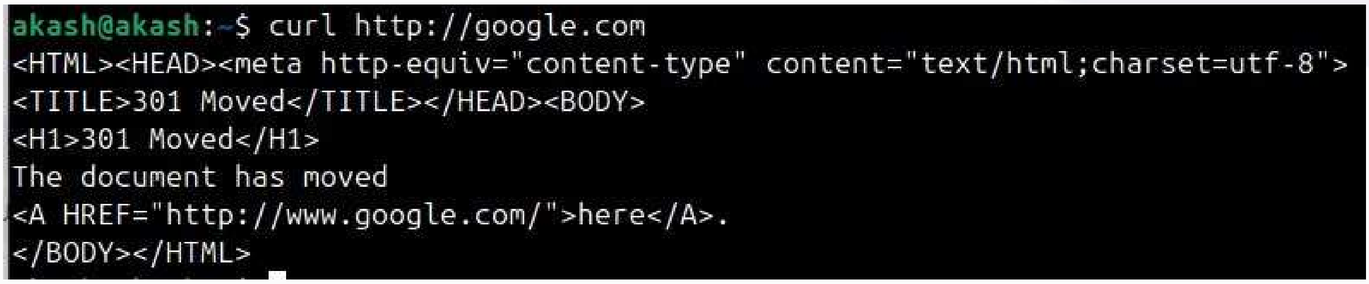
```
tcp
No.     Time            Source                  Destination             Protocol  Length Info
    428 54.910155309  2409:40f4:214d:826e… 2a03:2880:f237:1d1:… TCP       1374 52896 → 443 [PSH, ACK] Seq=74209 Ack=243095 Win=4018 Le…
    429 54.910520571  2409:40f4:214d:826e… 2a03:2880:f237:1d1:… TCP       1374 52896 → 443 [ACK] Seq=75497 Ack=243095 Win=4018 Len=128…
    430 54.910523009  2409:40f4:214d:826e… 2a03:2880:f237:1d1:… TCP       1374 52896 → 443 [PSH, ACK] Seq=76785 Ack=243095 Win=4018 Le…
    431 54.910532210  2409:40f4:214d:826e… 2a03:2880:f237:1d1:… TCP       1374 52896 → 443 [ACK] Seq=78073 Ack=243095 Win=4018 Len=128…
    432 54.910532706  2409:40f4:214d:826e… 2a03:2880:f237:1d1:… TCP       1374 52896 → 443 [PSH, ACK] Seq=79361 Ack=243095 Win=4018 Le…
    433 54.910806771  2409:40f4:214d:826e… 2a03:2880:f237:1d1:… TCP       1374 52896 → 443 [ACK] Seq=80649 Ack=243095 Win=4018 Len=128…
    434 54.910808466  2409:40f4:214d:826e… 2a03:2880:f237:1d1:… TLSv1.2    236 Application Data
    435 55.243486851  2a03:2880:f237:1d1:… 2409:40f4:214d:826e… TCP         86 443 → 52896 [ACK] Seq=243095 Ack=71633 Win=2038 Len=0 T…
    436 55.243487796  2a03:2880:f237:1d1:… 2409:40f4:214d:826e… TCP         86 443 → 52896 [ACK] Seq=243095 Ack=72921 Win=2038 Len=0 T…
    437 55.243487871  2a03:2880:f237:1d1:… 2409:40f4:214d:826e… TCP         86 443 → 52896 [ACK] Seq=243095 Ack=74209 Win=2038 Len=0 T…
    438 55.243487946  2a03:2880:f237:1d1:… 2409:40f4:214d:826e… TCP         86 443 → 52896 [ACK] Seq=243095 Ack=75497 Win=2038 Len=0 T…
    439 55.244966853  2a03:2880:f237:1d1:… 2409:40f4:214d:826e… TCP         86 443 → 52896 [ACK] Seq=243095 Ack=76785 Win=2038 Len=0 T…

▸ Frame 418: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on i
▸ Ethernet II, Src: 06:29:a6:a9:13:96 (06:29:a6:a9:13:96), Dst: PCSSystemte
▸ Internet Protocol Version 6, Src: 2404:6800:4003:c11::bc, Dst: 2409:40f4:
▾ Transmission Control Protocol, Src Port: 5228, Dst Port: 37150, Seq: 1, A
    Source Port: 5228
    Destination Port: 37150
    [Stream index: 2]
  ▸ [Conversation completeness: Incomplete (4)]
    [TCP Segment Len: 0]
    Sequence Number: 1    (relative sequence number)
    Sequence Number (raw): 1591455888
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 2    (relative ack number)
    Acknowledgment number (raw): 1564599209
    1000 .... = Header Length: 32 bytes (8)
  ▸ Flags: 0x010 (ACK)
    Window: 1049
    [Calculated window size: 1049]
    [Window size scaling factor: -1 (unknown)]
    Checksum: 0xaa18 [unverified]

0000  08 00 27 0e cd 8c 06 29  a6 a9 13 96 86 dd 68 08
0010  ce 2d 00 20 06 78 24 04  68 00 40 03 0c 11 00 00
0020  00 00 00 00 00 bc 24 09  40 f4 21 4d 82 6e 5c 22
0030  96 09 33 3d cd b9 14 6c  91 1e 5e db b0 90 5d 41
0040  e3 a9 80 10 04 19 aa 18  00 00 01 01 08 0a 94 6b
0050  31 0d 8d a7 aa d9
```

tcp traffic in wireshark

3

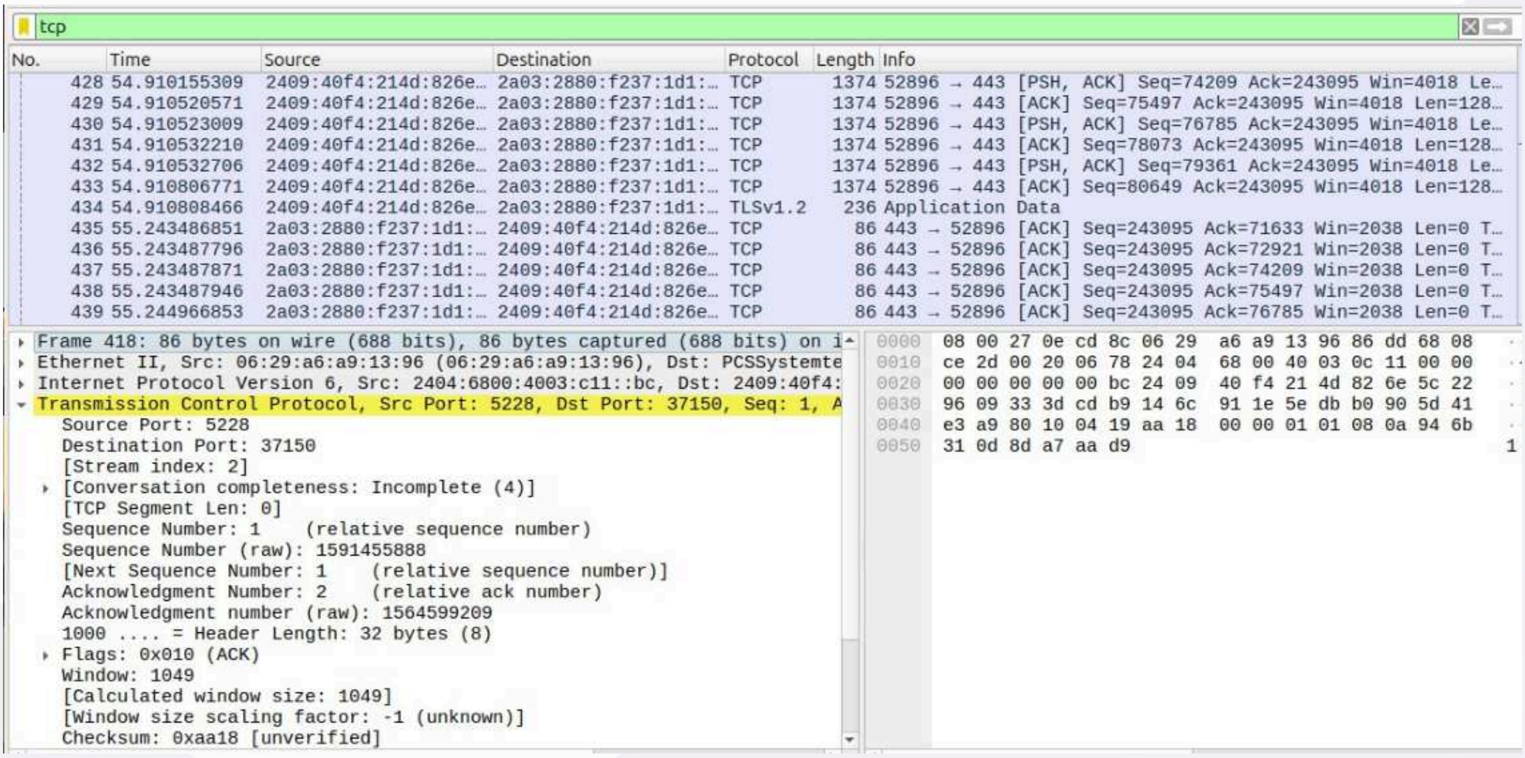
Capturing UDP Traffic:

- By running this command, we can capture TCP traffic
    - dig embedur.ai
- In wireshark, we can filter the traffic with the keyword **“udp”**



```
akash@akash:~$ curl http://google.com
<HTML><HEAD><meta http-equiv="content-type" content="text/html;charset=utf-8">
<TITLE>301 Moved</TITLE></HEAD><BODY>
<H1>301 Moved</H1>
The document has moved
<A HREF="http://www.google.com/">here</A>.
</BODY></HTML>
```

dig command



```
tcp
No.    Time          Source                Destination           Protocol  Length Info
   428 54.910155309  2409:40f4:214d:826e…  2a03:2880:f237:1d1:…  TCP        1374 52896 → 443 [PSH, ACK] Seq=74209 Ack=243095 Win=4018 Le…
   429 54.910520571  2409:40f4:214d:826e…  2a03:2880:f237:1d1:…  TCP        1374 52896 → 443 [ACK] Seq=75497 Ack=243095 Win=4018 Len=128…
   430 54.910523009  2409:40f4:214d:826e…  2a03:2880:f237:1d1:…  TCP        1374 52896 → 443 [PSH, ACK] Seq=76785 Ack=243095 Win=4018 Le…
   431 54.910532210  2409:40f4:214d:826e…  2a03:2880:f237:1d1:…  TCP        1374 52896 → 443 [ACK] Seq=78073 Ack=243095 Win=4018 Len=128…
   432 54.910532706  2409:40f4:214d:826e…  2a03:2880:f237:1d1:…  TCP        1374 52896 → 443 [PSH, ACK] Seq=79361 Ack=243095 Win=4018 Le…
   433 54.910806771  2409:40f4:214d:826e…  2a03:2880:f237:1d1:…  TCP        1374 52896 → 443 [ACK] Seq=80649 Ack=243095 Win=4018 Len=128…
   434 54.910808466  2409:40f4:214d:826e…  2a03:2880:f237:1d1:…  TLSv1.2     236 Application Data
   435 55.243486851  2a03:2880:f237:1d1:…  2409:40f4:214d:826e…  TCP          86 443 → 52896 [ACK] Seq=243095 Ack=71633 Win=2038 Len=0 T…
   436 55.243487796  2a03:2880:f237:1d1:…  2409:40f4:214d:826e…  TCP          86 443 → 52896 [ACK] Seq=243095 Ack=72921 Win=2038 Len=0 T…
   437 55.243487871  2a03:2880:f237:1d1:…  2409:40f4:214d:826e…  TCP          86 443 → 52896 [ACK] Seq=243095 Ack=74209 Win=2038 Len=0 T…
   438 55.243487946  2a03:2880:f237:1d1:…  2409:40f4:214d:826e…  TCP          86 443 → 52896 [ACK] Seq=243095 Ack=75497 Win=2038 Len=0 T…
   439 55.244966853  2a03:2880:f237:1d1:…  2409:40f4:214d:826e…  TCP          86 443 → 52896 [ACK] Seq=243095 Ack=76785 Win=2038 Len=0 T…

▸ Frame 418: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on i
▸ Ethernet II, Src: 06:29:a6:a9:13:96 (06:29:a6:a9:13:96), Dst: PCSSystemte
▸ Internet Protocol Version 6, Src: 2404:6800:4003:c11::bc, Dst: 2409:40f4:
▾ Transmission Control Protocol, Src Port: 5228, Dst Port: 37150, Seq: 1, A
    Source Port: 5228
    Destination Port: 37150
    [Stream index: 2]
  ▸ [Conversation completeness: Incomplete (4)]
    [TCP Segment Len: 0]
    Sequence Number: 1    (relative sequence number)
    Sequence Number (raw): 1591455888
    [Next Sequence Number: 1    (relative sequence number)]
    Acknowledgment Number: 2    (relative ack number)
    Acknowledgment number (raw): 1564599209
    1000 .... = Header Length: 32 bytes (8)
  ▸ Flags: 0x010 (ACK)
    Window: 1049
    [Calculated window size: 1049]
    [Window size scaling factor: -1 (unknown)]
    Checksum: 0xaa18 [unverified]

0000  08 00 27 0e cd 8c 06 29  a6 a9 13 96 86 dd 68 08
0010  ce 2d 00 20 06 78 24 04  68 00 40 03 0c 11 00 00
0020  00 00 00 00 00 bc 24 09  40 f4 21 4d 82 6e 5c 22
0030  96 09 33 3d cd b9 14 6c  91 1e 5e db b0 90 5d 41
0040  e3 a9 80 10 04 19 aa 18  00 00 01 01 08 0a 94 6b
0050  31 0d 8d a7 aa d9
```

udp traffic in wireshark

Qn 3:

Explore traceroute/tracert for different websites eg:google.com and analyse the parameters in the output and explore different options for traceroute command.

Traceroute:

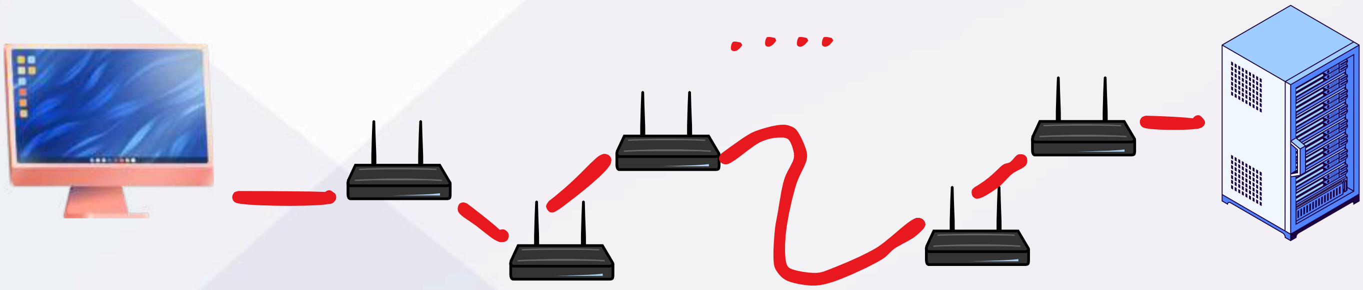
- Traceroute is a network diagnostic tool used to track the path that packets take from a source system to a destination across an IP network.
- It helps identify network congestion, routing issues, and unreachable nodes.

How traceroute works:

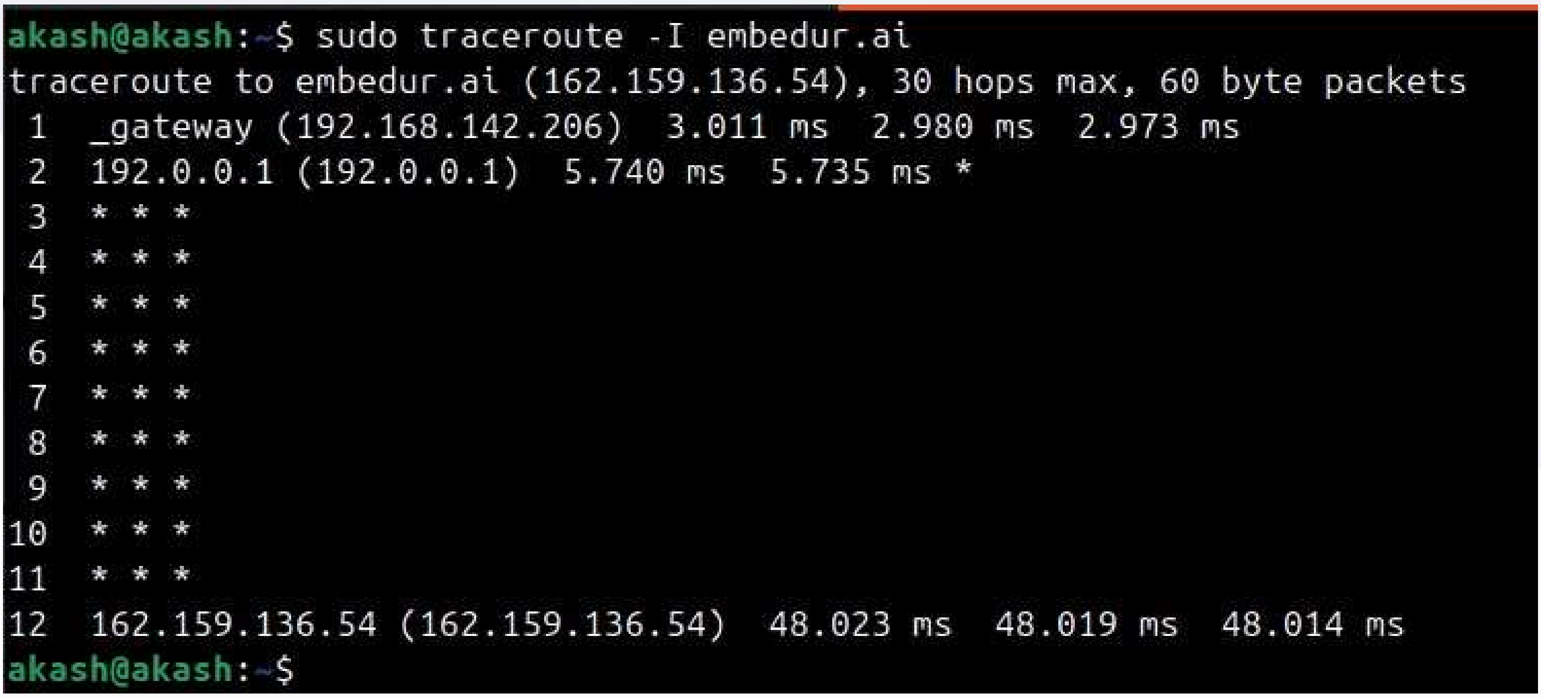
- While sending, the TTL value increases from 1
- Upon reaching each and every router, the TTL value is decremented by 1
    - When TTL=0, packet is dropped
- traceroute identifies time taken by each router to respond
- Once target responds, full path is recorded

Options in traceroute:

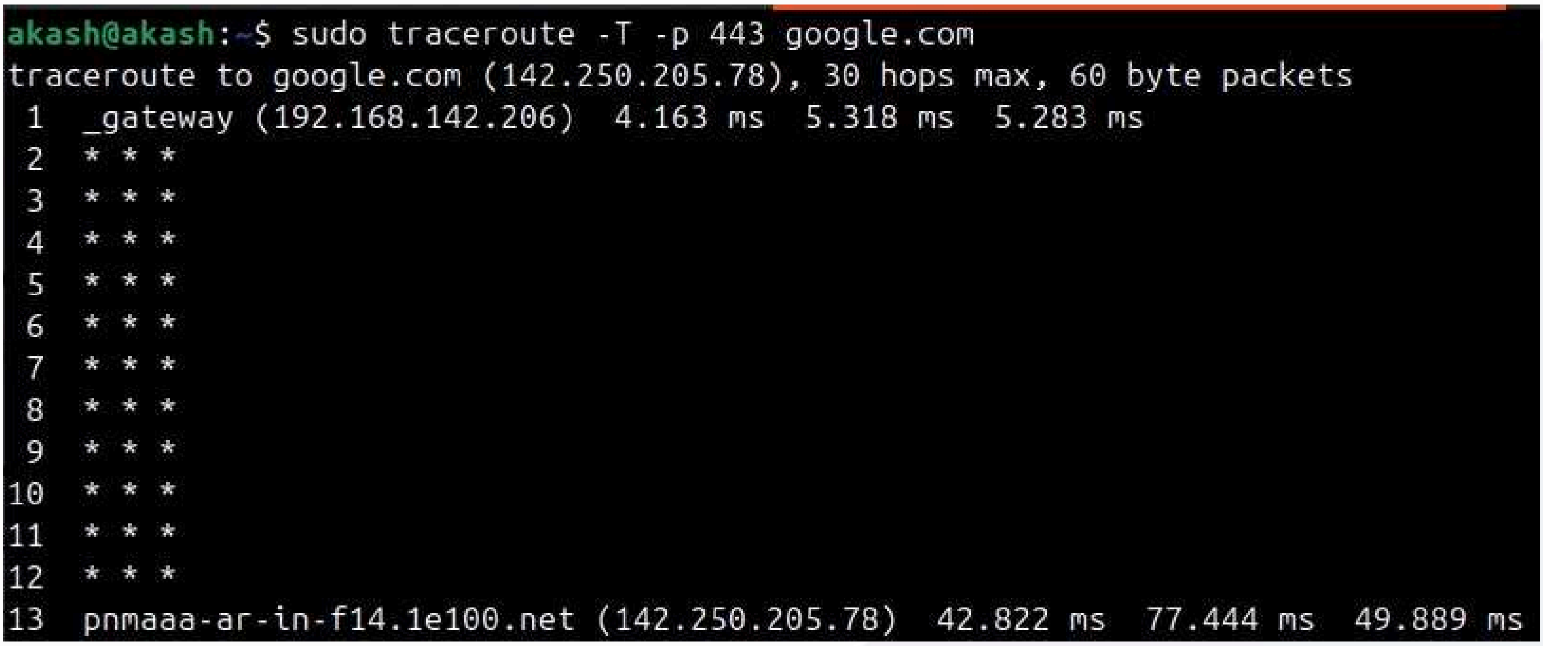
- -I : ICMP
- -T : TCP
- -p 23 : Destination Port number
- -m 35 : Maximum hops needed
- -w <time> : Timeout for each response
- -4 : IPv4
- -6 : IPv6



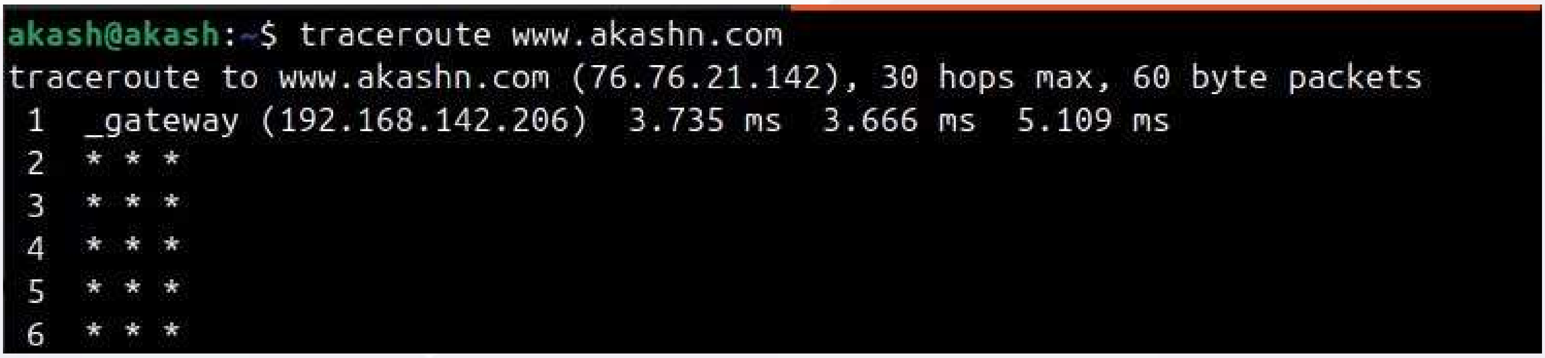
traceroute:



```
akash@akash:~$ sudo traceroute -I embedur.ai
traceroute to embedur.ai (162.159.136.54), 30 hops max, 60 byte packets
 1  _gateway (192.168.142.206)  3.011 ms  2.980 ms  2.973 ms
 2  192.0.0.1 (192.0.0.1)  5.740 ms  5.735 ms *
 3  * * *
 4  * * *
 5  * * *
 6  * * *
 7  * * *
 8  * * *
 9  * * *
10  * * *
11  * * *
12  162.159.136.54 (162.159.136.54)  48.023 ms  48.019 ms  48.014 ms
akash@akash:~$
```

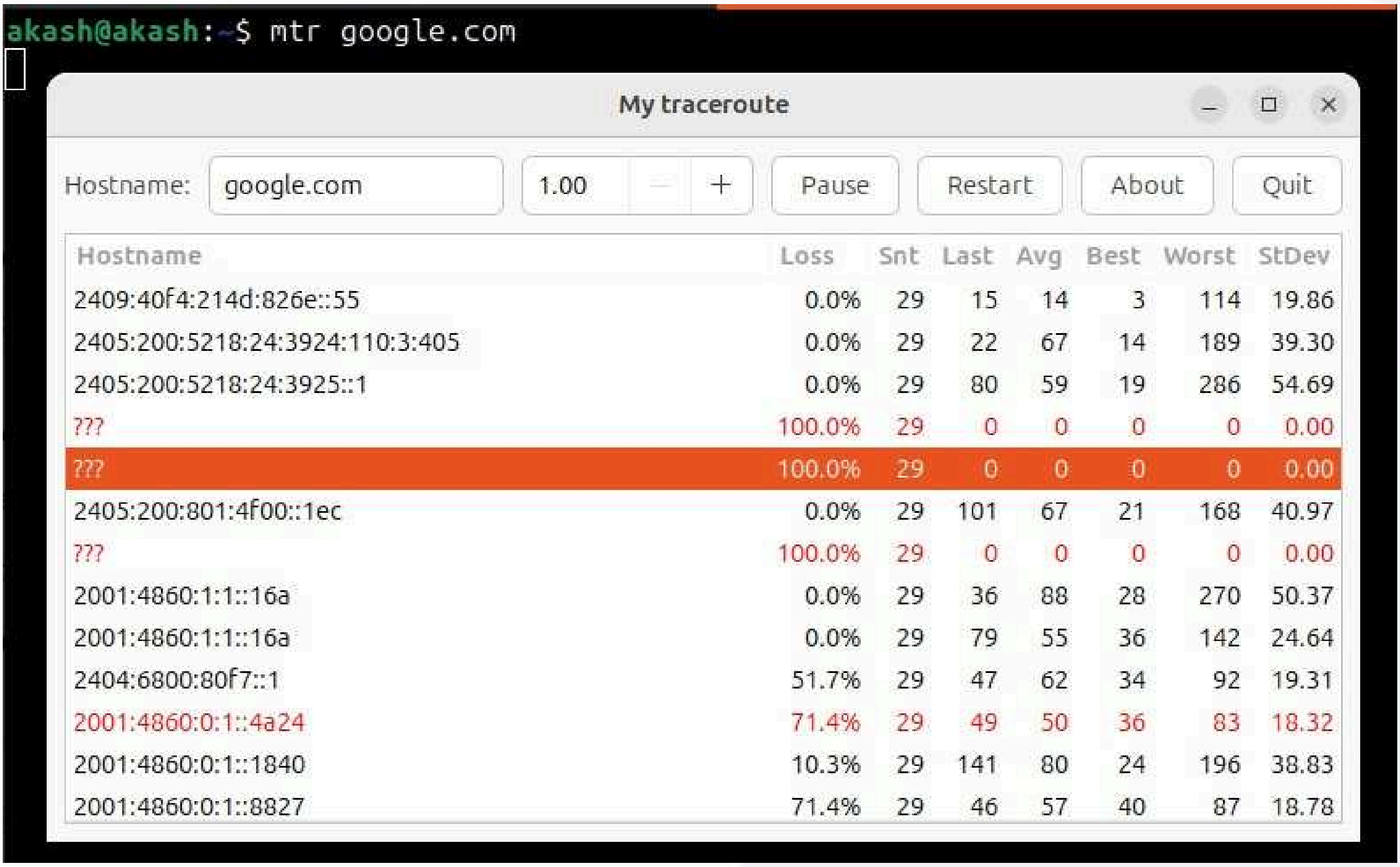


```
akash@akash:~$ sudo traceroute -T -p 443 google.com
traceroute to google.com (142.250.205.78), 30 hops max, 60 byte packets
 1  _gateway (192.168.142.206)  4.163 ms  5.318 ms  5.283 ms
 2  * * *
 3  * * *
 4  * * *
 5  * * *
 6  * * *
 7  * * *
 8  * * *
 9  * * *
10  * * *
11  * * *
12  * * *
13  pnmaaa-ar-in-f14.1e100.net (142.250.205.78)  42.822 ms  77.444 ms  49.889 ms
```



```
akash@akash:~$ traceroute www.akashn.com
traceroute to www.akashn.com (76.76.21.142), 30 hops max, 60 byte packets
 1  _gateway (192.168.142.206)  3.735 ms  3.666 ms  5.109 ms
 2  * * *
 3  * * *
 4  * * *
 5  * * *
 6  * * *
```

Detailed traceroute analysis using mtr:



```
akash@akash:~$ mtr google.com
```

Hostname: google.com 1.00

Hostname	Loss	Snt	Last	Avg	Best	Worst	StDev
2409:40f4:214d:826e::55	0.0%	29	15	14	3	114	19.86
2405:200:5218:24:3924:110:3:405	0.0%	29	22	67	14	189	39.30
2405:200:5218:24:3925::1	0.0%	29	80	59	19	286	54.69
???	100.0%	29	0	0	0	0	0.00
???	100.0%	29	0	0	0	0	0.00
2405:200:801:4f00::1ec	0.0%	29	101	67	21	168	40.97
???	100.0%	29	0	0	0	0	0.00
2001:4860:1:1::16a	0.0%	29	36	88	28	270	50.37
2001:4860:1:1::16a	0.0%	29	79	55	36	142	24.64
2404:6800:80f7::1	51.7%	29	47	62	34	92	19.31
2001:4860:0:1::4a24	71.4%	29	49	50	36	83	18.32
2001:4860:0:1::1840	10.3%	29	141	80	24	196	38.83
2001:4860:0:1::8827	71.4%	29	46	57	40	87	18.78

Qn 4 - 10:

Network Topology in Cisco Packet Tracer

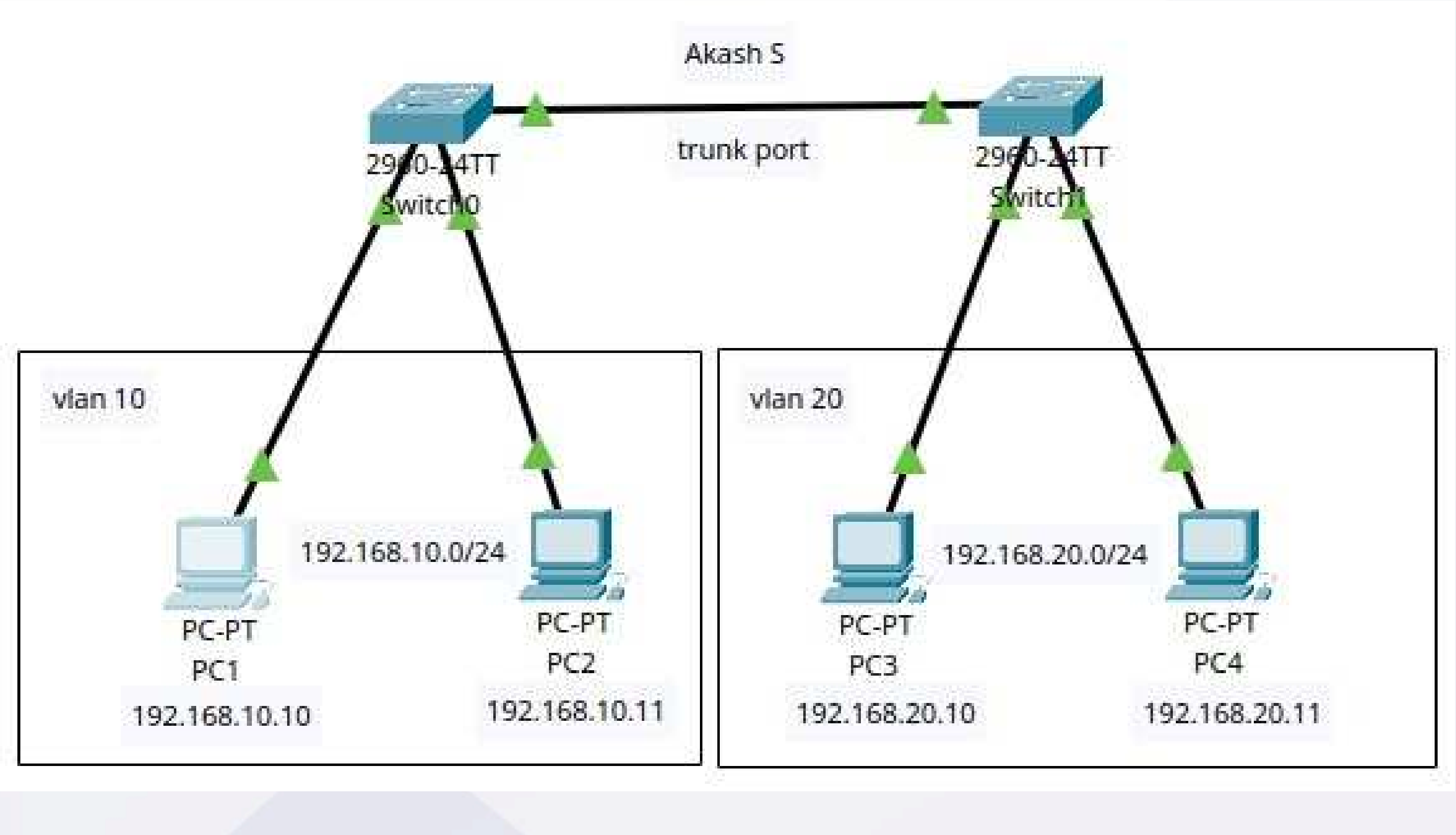
- VLAN, SSH/Telnet, Troubleshooting, Inter VLAN Routing

VLAN:

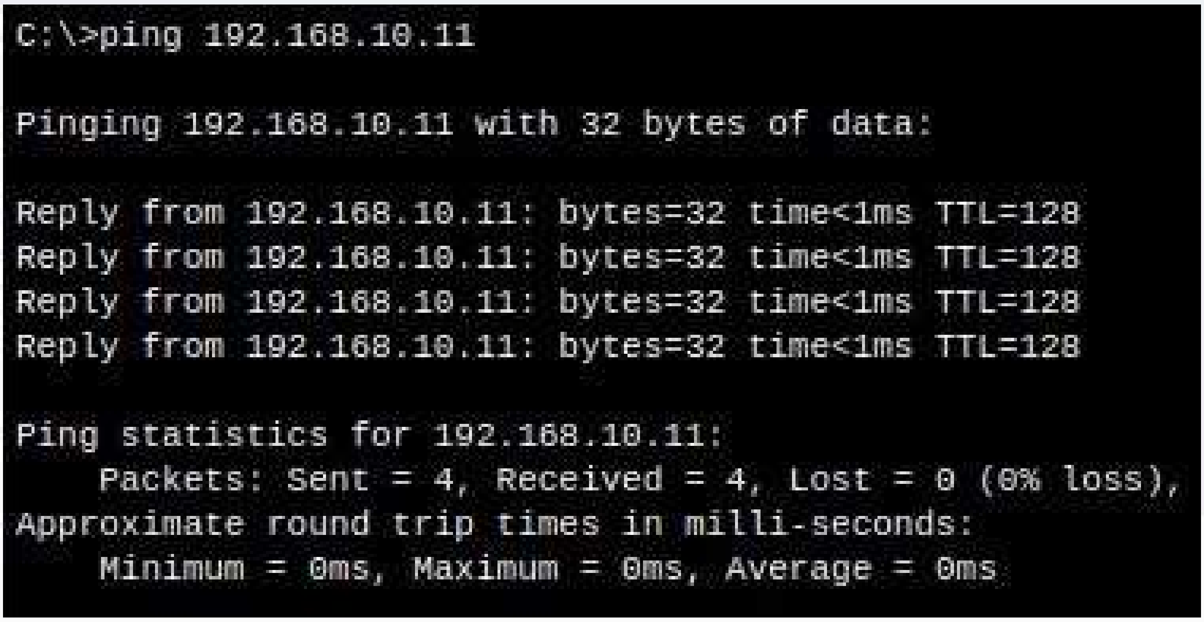
- VLANs (Virtual Local Area Networks)
- VLANs segment a network to separate traffic logically rather than physically.
- Devices in the same VLAN can communicate, but different VLANs need a Layer 3 device (router or Layer 3 switch) for communication.

Trunk Port:

- A trunk port is a switch port that carries multiple VLANs over a single physical link between network devices like switches or routers.
- It uses **802.1Q encapsulation** to tag VLAN traffic to differentiate different vlan when they travel across the trunk.



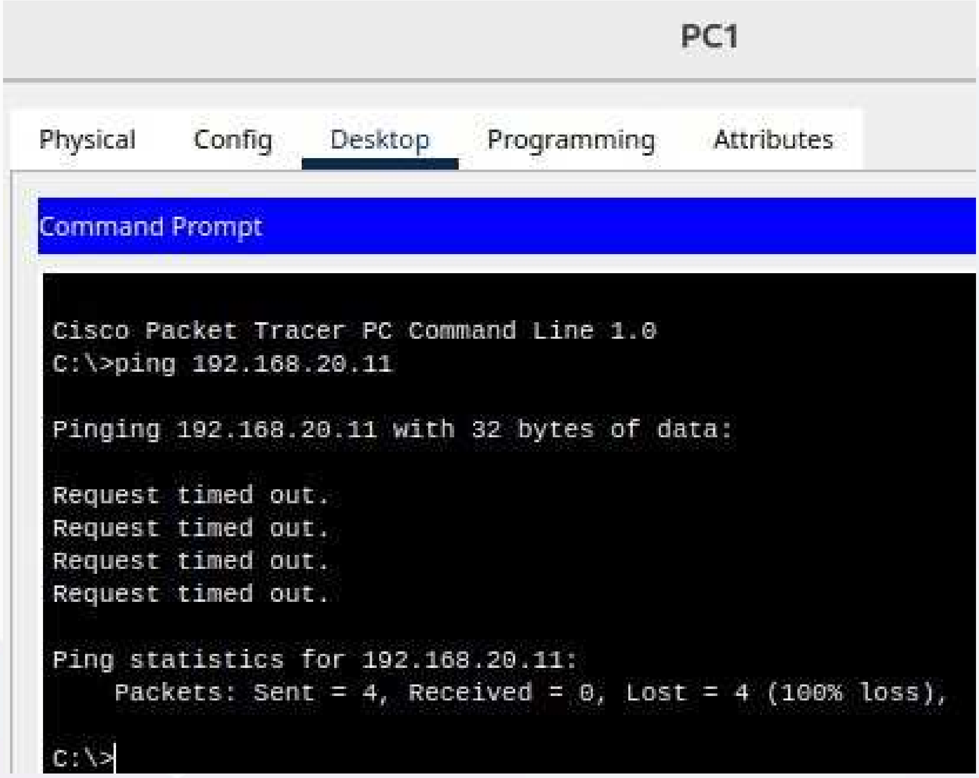
Pinging from PC1 to PC2:



```
C:\>ping 192.168.10.11

Pinging 192.168.10.11 with 32 bytes of data:

Reply from 192.168.10.11: bytes=32 time<1ms TTL=128
Reply from 192.168.10.11: bytes=32 time<1ms TTL=128
Reply from 192.168.10.11: bytes=32 time<1ms TTL=128
Reply from 192.168.10.11: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.10.11:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

There ‘s a problem!

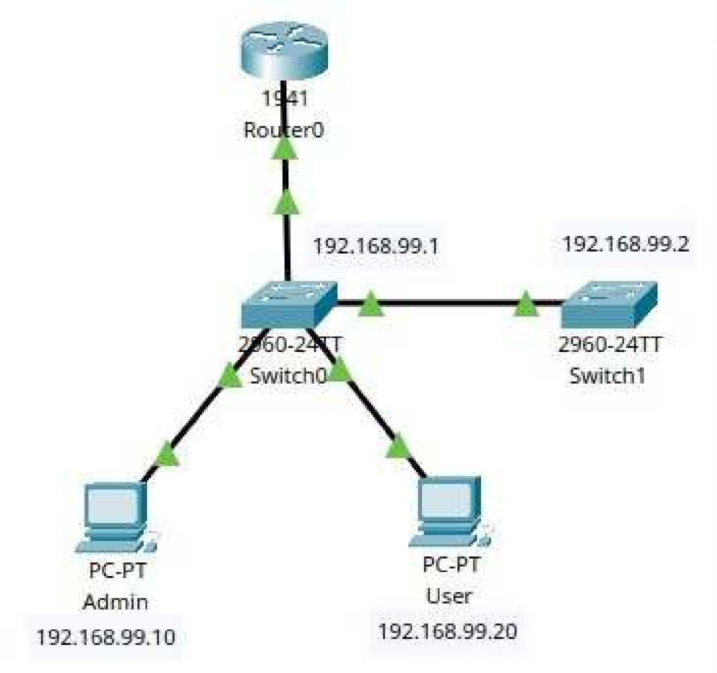
- Pinging works only inside the same vlan
- When I pinged from PC 1 to PC2, it worked
- When I pinged from PC3 to PC4, it worked
- But when I pinged from PC1 to PC3 or PC4, it didn’t work

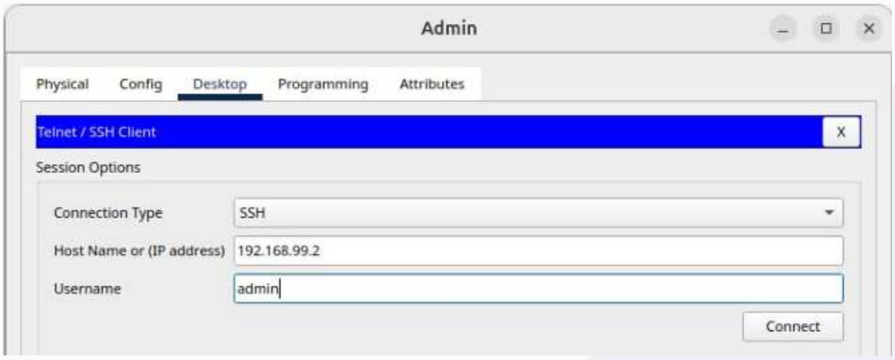


```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.20.11

Pinging 192.168.20.11 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.20.11:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

Testing SSH/Telnet:

- I configured a network by connecting two PCs for remote access
    - PC1: **192.168.99.10**
    - PC2: **192.168.99.20**
- I connected two switches and a router
- When I tried connected to the host machine using ssh, it worked
    - **ssh akash@192.168.99.2**



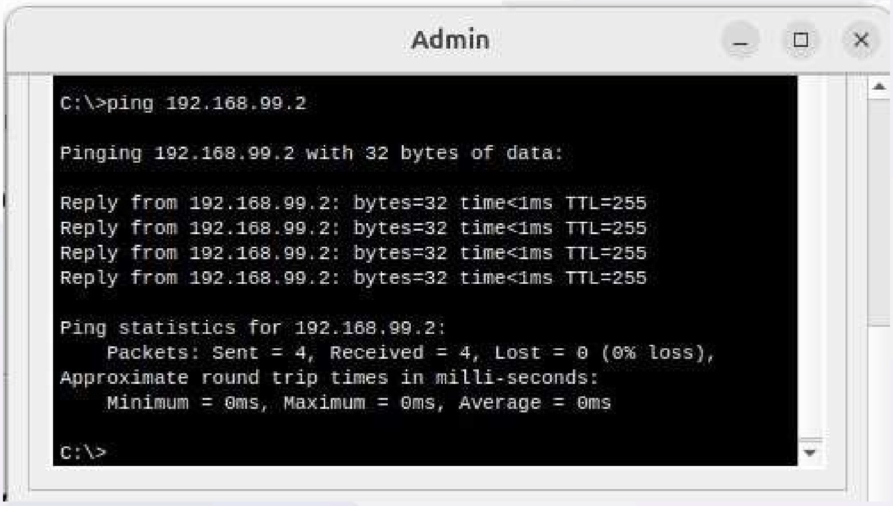


Session Options

Connection Type: SSH

Host Name or (IP address): 192.168.99.2

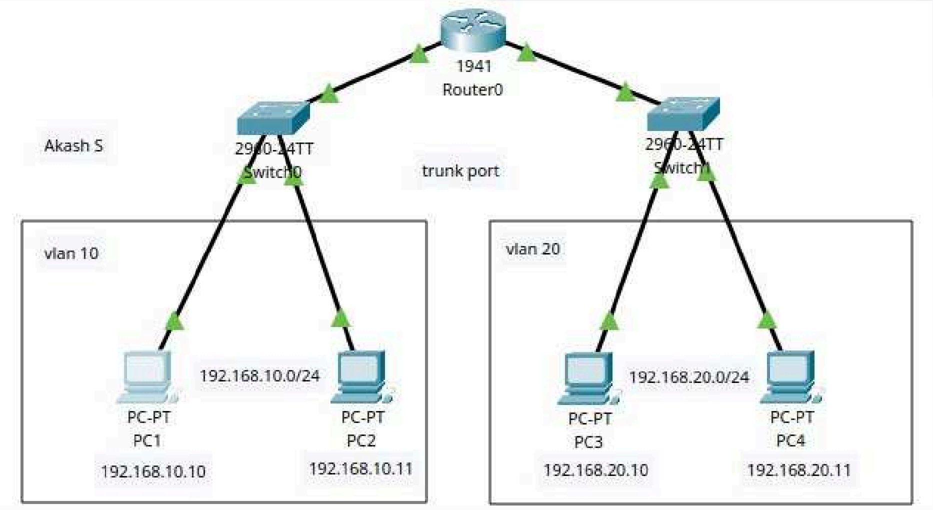
Username: admin

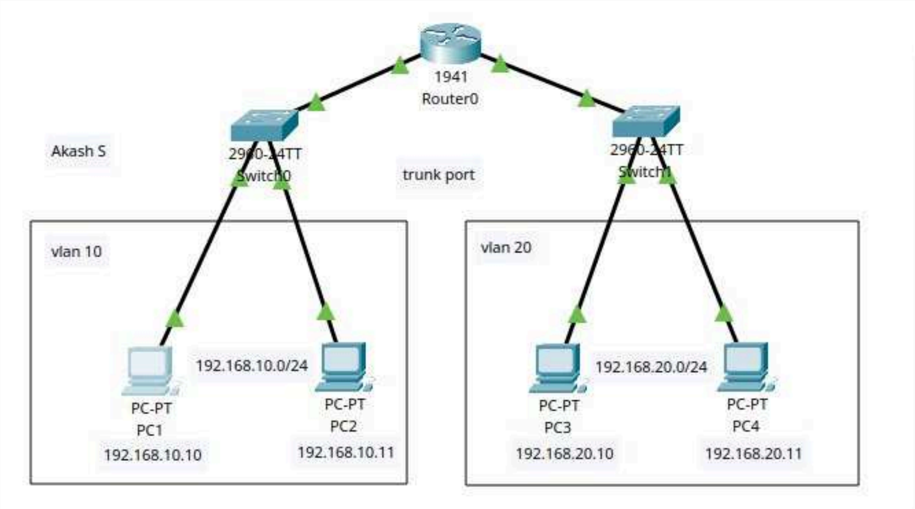


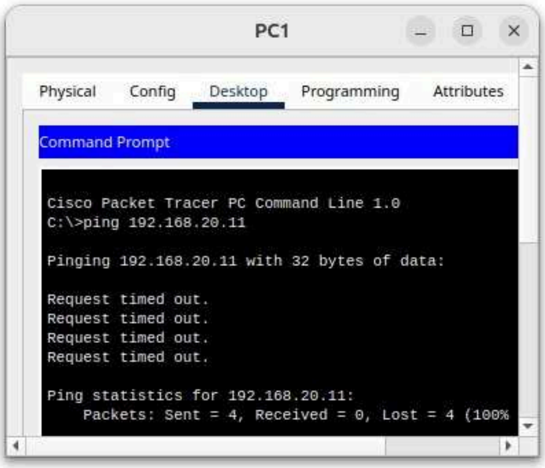
```
C:\>ping 192.168.99.2

Pinging 192.168.99.2 with 32 bytes of data:

Reply from 192.168.99.2: bytes=32 time<1ms TTL=255
Reply from 192.168.99.2: bytes=32 time<1ms TTL=255
Reply from 192.168.99.2: bytes=32 time<1ms TTL=255
Reply from 192.168.99.2: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.99.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

Troubleshooting Inter-VLAN pinging:

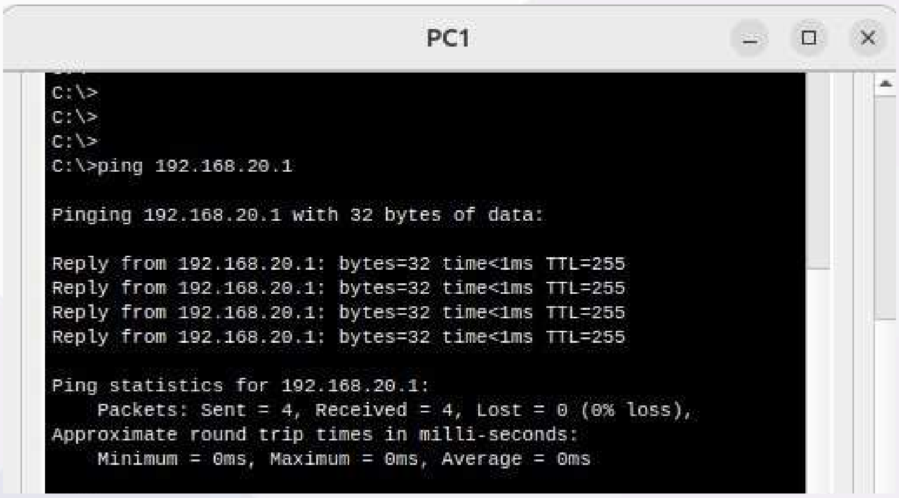
- When I tried pinging from different VLAN to a different VLAN, it failed.
- What could be the reason?
- After several attempts, I realized that VLANs need routers to connect across different VLANs.
- So I connected a router connecting two switches.







```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.20.11

Pinging 192.168.20.11 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.20.11:
    Packets: Sent = 4, Received = 0, Lost = 4 (100%
```



```
C:\>
C:\>
C:\>
C:\>ping 192.168.20.1

Pinging 192.168.20.1 with 32 bytes of data:

Reply from 192.168.20.1: bytes=32 time<1ms TTL=255
Reply from 192.168.20.1: bytes=32 time<1ms TTL=255
Reply from 192.168.20.1: bytes=32 time<1ms TTL=255
Reply from 192.168.20.1: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.20.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Qn 11:

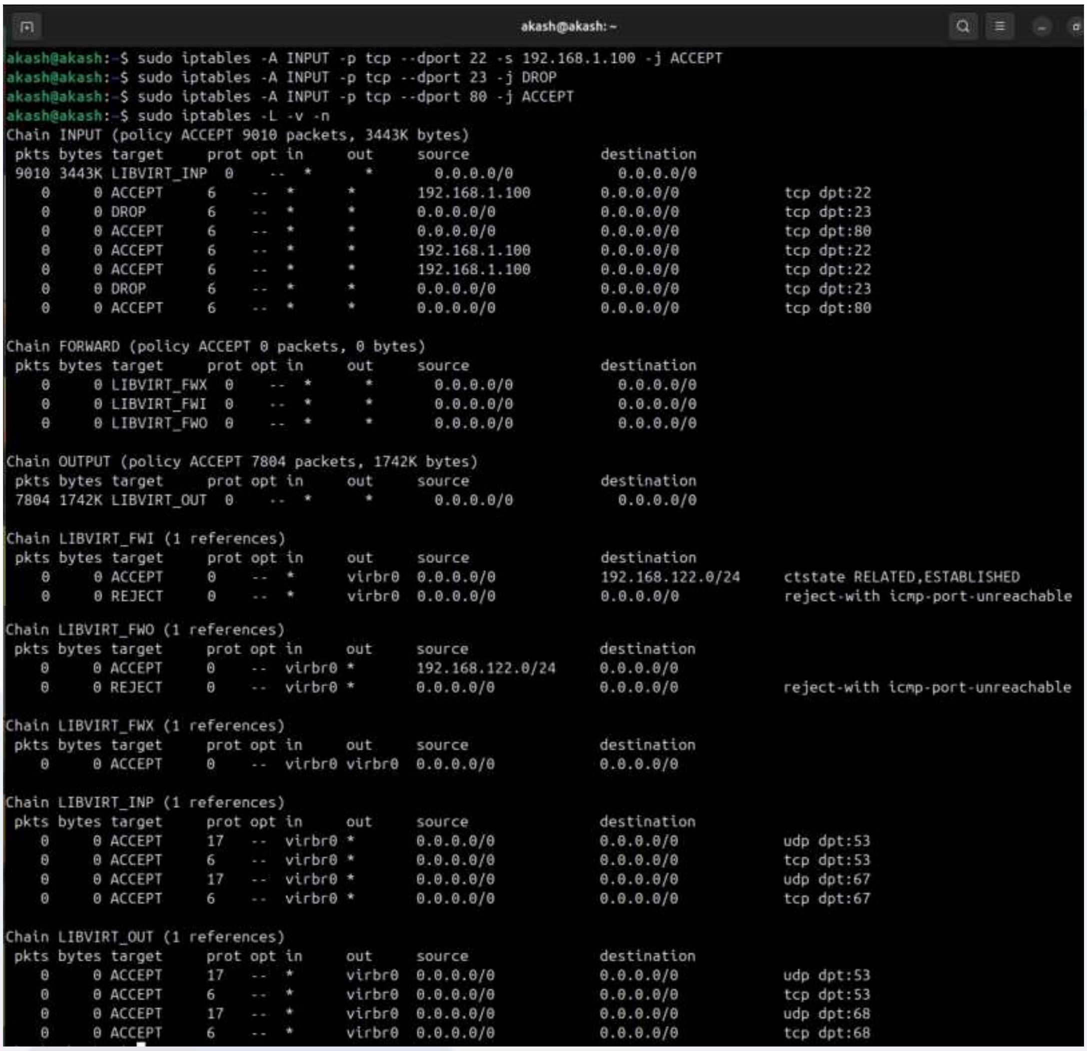
Implement ACLs to restrict traffic based on source and destination ports. Test rules by simulating legitimate and unauthorized traffic.

ACL:

- **Access Control Lists** are used to filter network traffic based on rules. They can control which packets are allowed or denied based on parameters such as source/destination IP addresses, protocols, and ports. This helps in enforcing security policies and managing traffic efficiently.

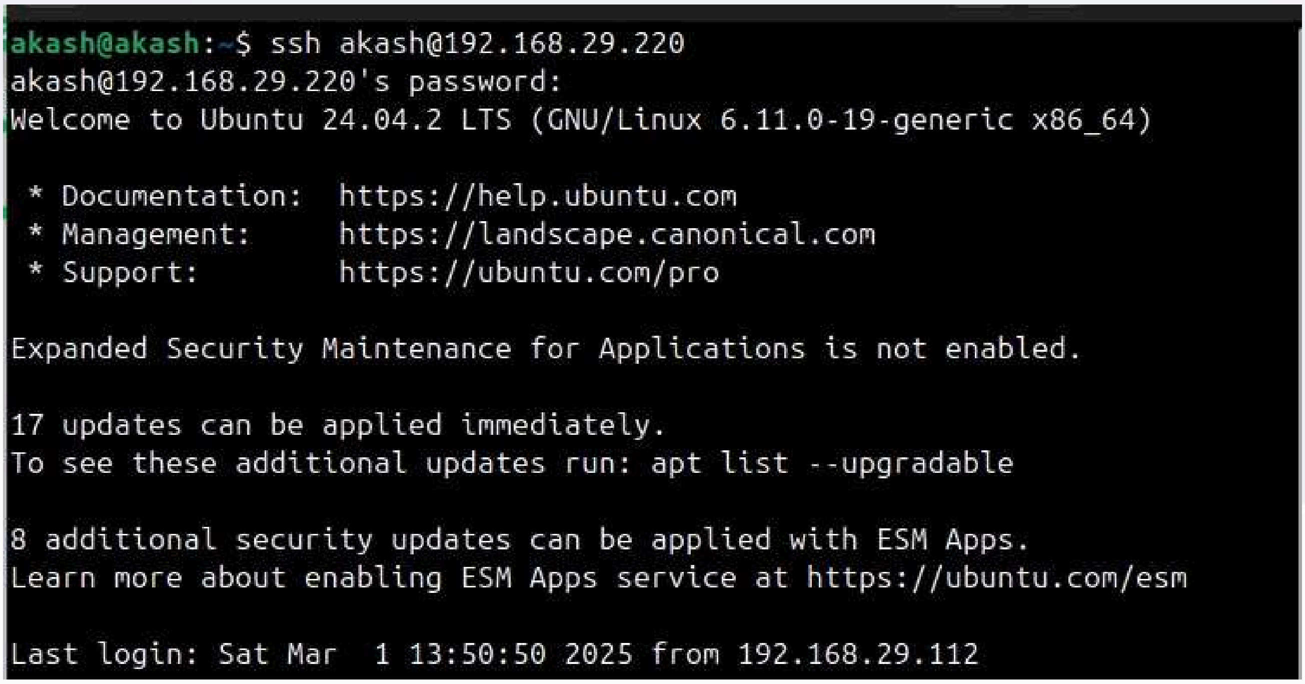
Steps I followed:

- I created an extended ACL
- I blocked SSH (port 22)
- I allowed HTTP (port 80)
- I also blocked ICMP ping requests to check how it works.

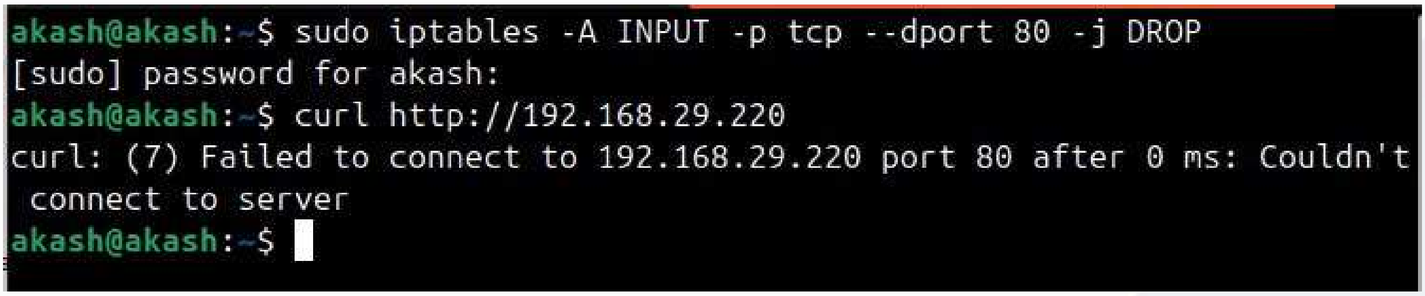


```
akash@akash:~$ sudo iptables -A INPUT -p tcp --dport 22 -s 192.168.1.100 -j ACCEPT
akash@akash:~$ sudo iptables -A INPUT -p tcp --dport 23 -j DROP
akash@akash:~$ sudo iptables -A INPUT -p tcp --dport 80 -j ACCEPT
akash@akash:~$ sudo iptables -L -v -n
Chain INPUT (policy ACCEPT 9010 packets, 3443K bytes)
 pkts bytes target     prot opt in     out     source               destination
 9010 3443K LIBVIRT_INP  0    --  *      *       0.0.0.0/0            0.0.0.0/0
    0     0 ACCEPT     6    --  *      *       192.168.1.100        0.0.0.0/0            tcp dpt:22
    0     0 DROP       6    --  *      *       0.0.0.0/0            0.0.0.0/0            tcp dpt:23
    0     0 ACCEPT     6    --  *      *       0.0.0.0/0            0.0.0.0/0            tcp dpt:80
    0     0 ACCEPT     6    --  *      *       192.168.1.100        0.0.0.0/0            tcp dpt:22
    0     0 ACCEPT     6    --  *      *       192.168.1.100        0.0.0.0/0            tcp dpt:22
    0     0 DROP       6    --  *      *       0.0.0.0/0            0.0.0.0/0            tcp dpt:23
    0     0 ACCEPT     6    --  *      *       0.0.0.0/0            0.0.0.0/0            tcp dpt:80

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination
    0     0 LIBVIRT_FWX  0    --  *      *       0.0.0.0/0            0.0.0.0/0
    0     0 LIBVIRT_FWI  0    --  *      *       0.0.0.0/0            0.0.0.0/0
    0     0 LIBVIRT_FWO  0    --  *      *       0.0.0.0/0            0.0.0.0/0

Chain OUTPUT (policy ACCEPT 7804 packets, 1742K bytes)
 pkts bytes target     prot opt in     out     source               destination
 7804 1742K LIBVIRT_OUT  0    --  *      *       0.0.0.0/0            0.0.0.0/0

Chain LIBVIRT_FWI (1 references)
 pkts bytes target     prot opt in     out     source               destination
    0     0 ACCEPT     0    --  *      virbr0  0.0.0.0/0            192.168.122.0/24     ctstate RELATED,ESTABLISHED
    0     0 REJECT     0    --  *      virbr0  0.0.0.0/0            0.0.0.0/0            reject-with icmp-port-unreachable

Chain LIBVIRT_FWO (1 references)
 pkts bytes target     prot opt in     out     source               destination
    0     0 ACCEPT     0    --  virbr0 *       192.168.122.0/24     0.0.0.0/0
    0     0 REJECT     0    --  virbr0 *       0.0.0.0/0            0.0.0.0/0            reject-with icmp-port-unreachable

Chain LIBVIRT_FWX (1 references)
 pkts bytes target     prot opt in     out     source               destination
    0     0 ACCEPT     0    --  virbr0 virbr0  0.0.0.0/0            0.0.0.0/0

Chain LIBVIRT_INP (1 references)
 pkts bytes target     prot opt in     out     source               destination
    0     0 ACCEPT     17   --  virbr0 *       0.0.0.0/0            0.0.0.0/0            udp dpt:53
    0     0 ACCEPT     6    --  virbr0 *       0.0.0.0/0            0.0.0.0/0            tcp dpt:53
    0     0 ACCEPT     17   --  virbr0 *       0.0.0.0/0            0.0.0.0/0            udp dpt:67
    0     0 ACCEPT     6    --  virbr0 *       0.0.0.0/0            0.0.0.0/0            tcp dpt:67

Chain LIBVIRT_OUT (1 references)
 pkts bytes target     prot opt in     out     source               destination
    0     0 ACCEPT     17   --  *      virbr0  0.0.0.0/0            0.0.0.0/0            udp dpt:53
    0     0 ACCEPT     6    --  *      virbr0  0.0.0.0/0            0.0.0.0/0            tcp dpt:53
    0     0 ACCEPT     17   --  *      virbr0  0.0.0.0/0            0.0.0.0/0            udp dpt:68
    0     0 ACCEPT     6    --  *      virbr0  0.0.0.0/0            0.0.0.0/0            tcp dpt:68
```

Testing how it works:



```
akash@akash:~$ ssh akash@192.168.29.220
akash@192.168.29.220's password:
Welcome to Ubuntu 24.04.2 LTS (GNU/Linux 6.11.0-19-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro

Expanded Security Maintenance for Applications is not enabled.

17 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

8 additional security updates can be applied with ESM Apps.
Learn more about enabling ESM Apps service at https://ubuntu.com/esm

Last login: Sat Mar  1 13:50:50 2025 from 192.168.29.112
```



```
akash@akash:~$ sudo iptables -A INPUT -p tcp --dport 80 -j DROP
[sudo] password for akash:
akash@akash:~$ curl http://192.168.29.220
curl: (7) Failed to connect to 192.168.29.220 port 80 after 0 ms: Couldn't
 connect to server
akash@akash:~$ 
```

Two main commands:

- **ACCEPT:** To allow the port
- **DROP:** To block the port

Takeaway:

- The above captures explain how the access is denied or controlled based on the specific port or ip address
- It is useful when we want to allow only limited IPs or Ports in an organization

Qn 12 & 13:

Configure a standard Access Control List (ACL) on a router to permit traffic from a specific IP range. Test connectivity to verify the ACL is working as intended.

Create an extended ACL to block specific applications, such as HTTP or FTP traffic. Test the ACL rules by attempting to access blocked services.

Permit IP Range in ACL:

Steps I followed:

- I tried this task by setting a network topology in the Cisco Packet Tracer.
- I decided to allow traffic only from 192.168.1.0/24 and block all other sources.
- Since standard ACLs filter only based on source IP, I had to ensure correct placement.

Configuring ACL on router:

- I used these commands,
  - **access-list 10 permit 192.168.1.0 0.0.0.255**
  - **access-list 10 deny any**

Applying ACL to interface:

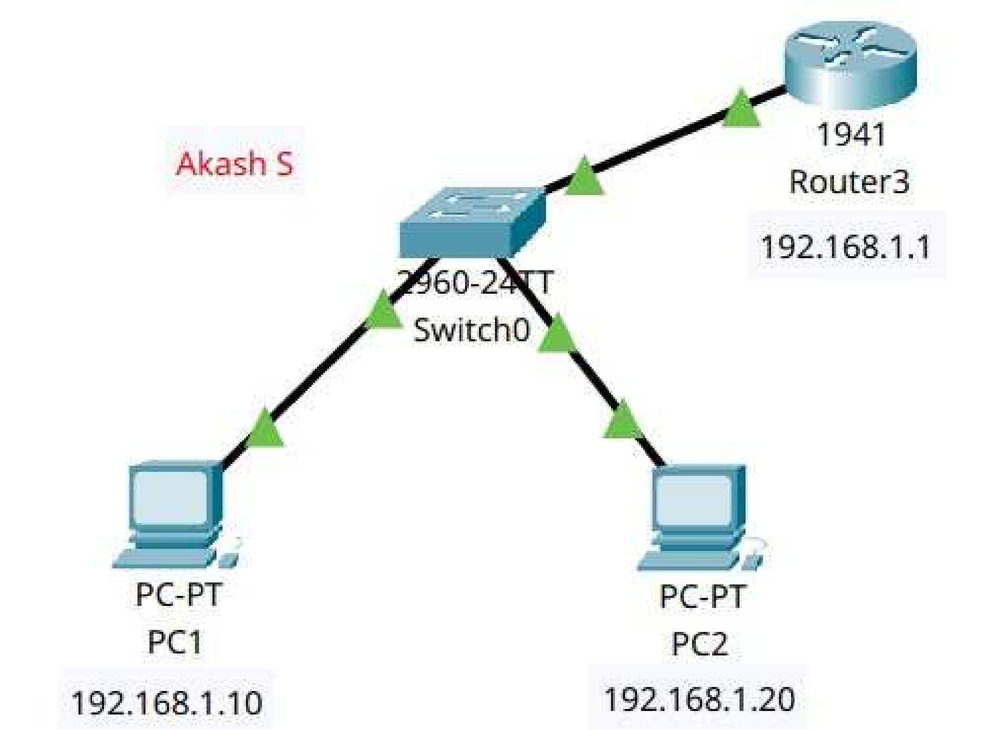
- These commands are used to apply ACL to interface
  - **interface GigabitEthernet0/0**
  - **ip access-group 10 in**
  - **exit**

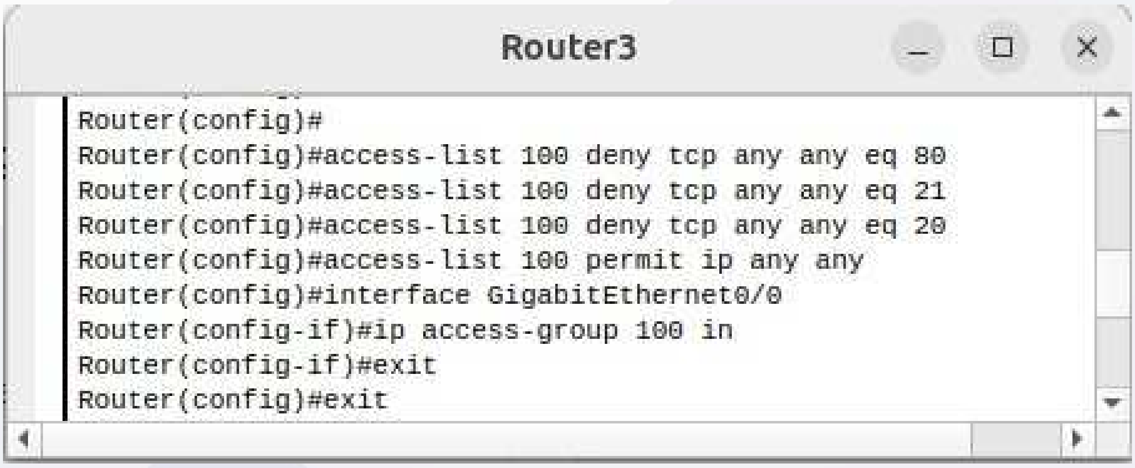
Testing:

- A PC from the 192.168.1.0/24 range successfully accessed the router.
- A PC from a different subnet was unable to connect.
- Ping tests from an unauthorized subnet failed, confirming that the ACL was applied correctly.

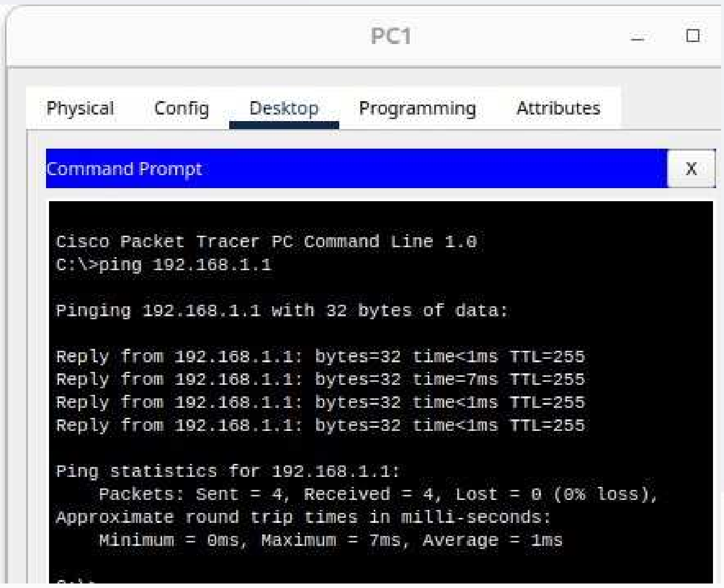
Attempt 1:

- I created a simple network to test first.
- Added two PCs, a switch and a router.

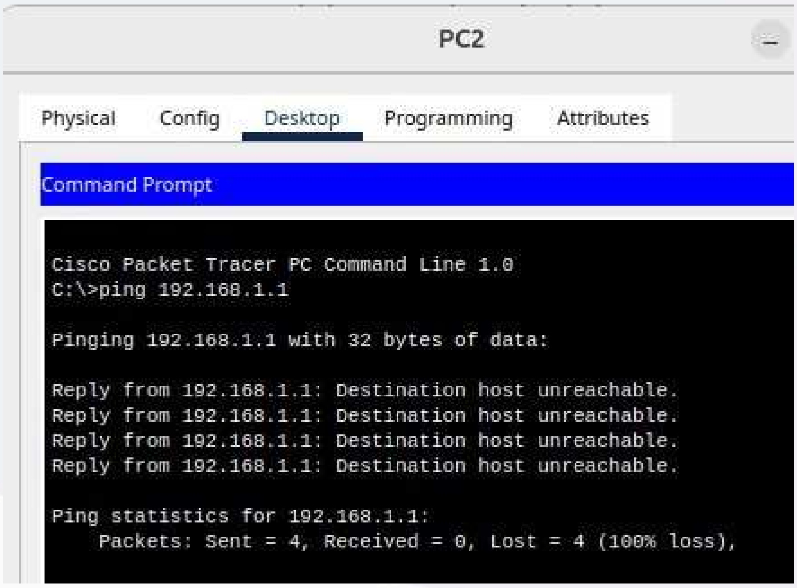




```
Router(config)#
Router(config)#access-list 100 deny tcp any any eq 80
Router(config)#access-list 100 deny tcp any any eq 21
Router(config)#access-list 100 deny tcp any any eq 20
Router(config)#access-list 100 permit ip any any
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip access-group 100 in
Router(config-if)#exit
Router(config)#exit
```



```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: bytes=32 time<1ms TTL=255
Reply from 192.168.1.1: bytes=32 time=7ms TTL=255
Reply from 192.168.1.1: bytes=32 time<1ms TTL=255
Reply from 192.168.1.1: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 7ms, Average = 1ms
```

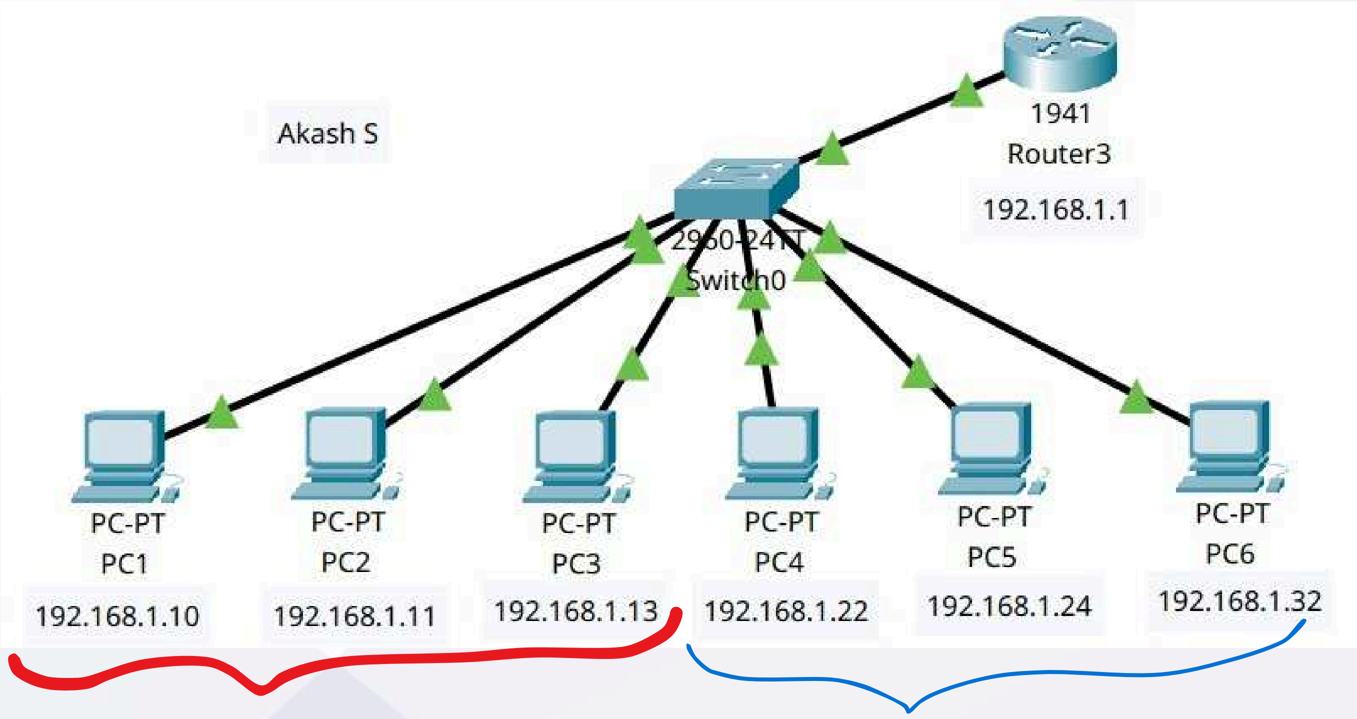


```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

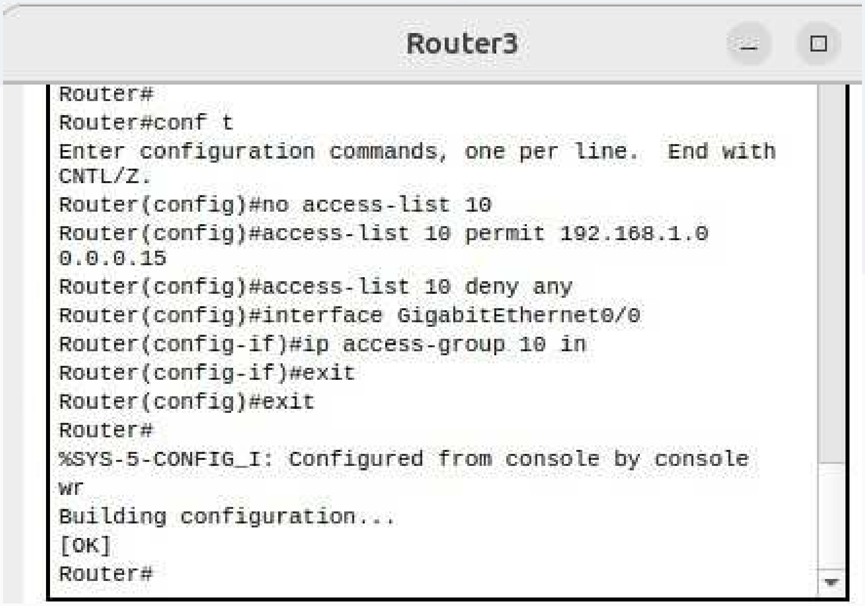
- For testing purpose, I created a simple network to allow and check
- Finally, the test network worked
- So, implementing the actual network with multiple devices

Actual Network:

- I constructed a network with 6 PCs, and I mentioned the network as **/28** so it allowed the range 0-15
- I used a wildcard mask to allow only first 15 and block the rest
- I configured this on the router

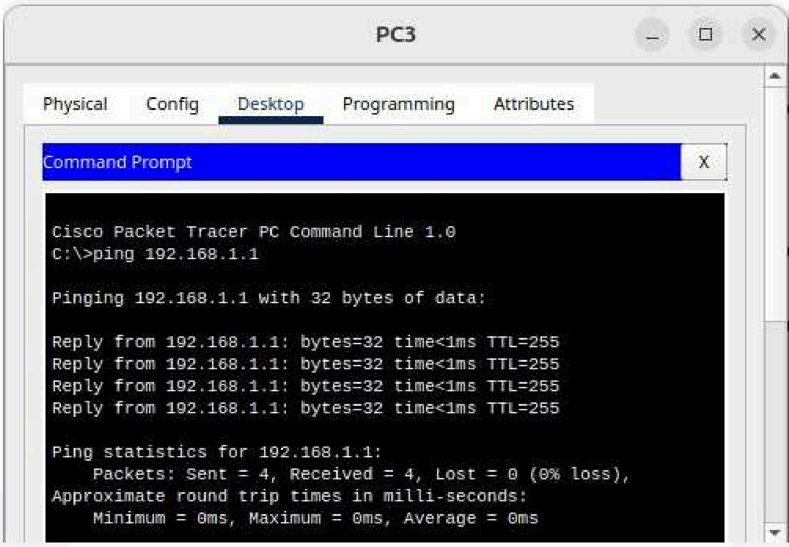


Router Configuration:

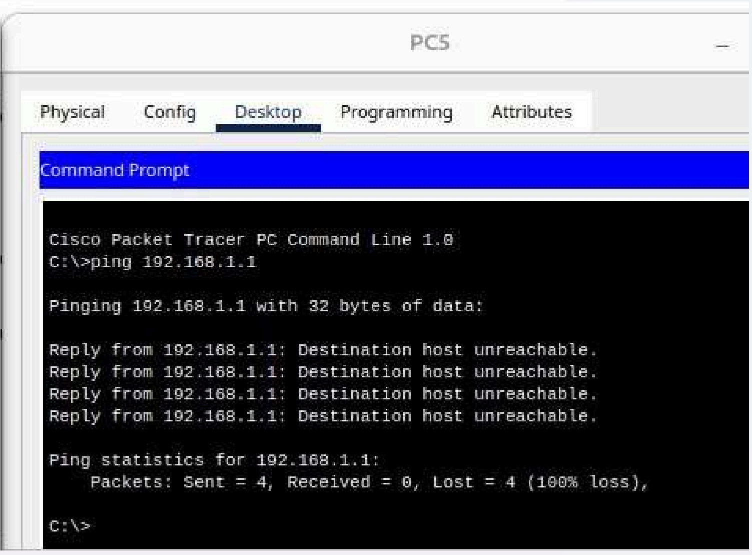


```
Router#
Router#conf t
Enter configuration commands, one per line.  End with
CNTL/Z.
Router(config)#no access-list 10
Router(config)#access-list 10 permit 192.168.1.0
0.0.0.15
Router(config)#access-list 10 deny any
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip access-group 10 in
Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
wr
Building configuration...
[OK]
Router#
```

- After masking with wildcard mask, the allowed and denied PCs are
  - PC1, PC2 & PC3 - range: **192.168.1.0 - 192.168.1.15**



```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: bytes=32 time<1ms TTL=255
Reply from 192.168.1.1: bytes=32 time<1ms TTL=255
Reply from 192.168.1.1: bytes=32 time<1ms TTL=255
Reply from 192.168.1.1: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```



```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.
Reply from 192.168.1.1: Destination host unreachable.

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

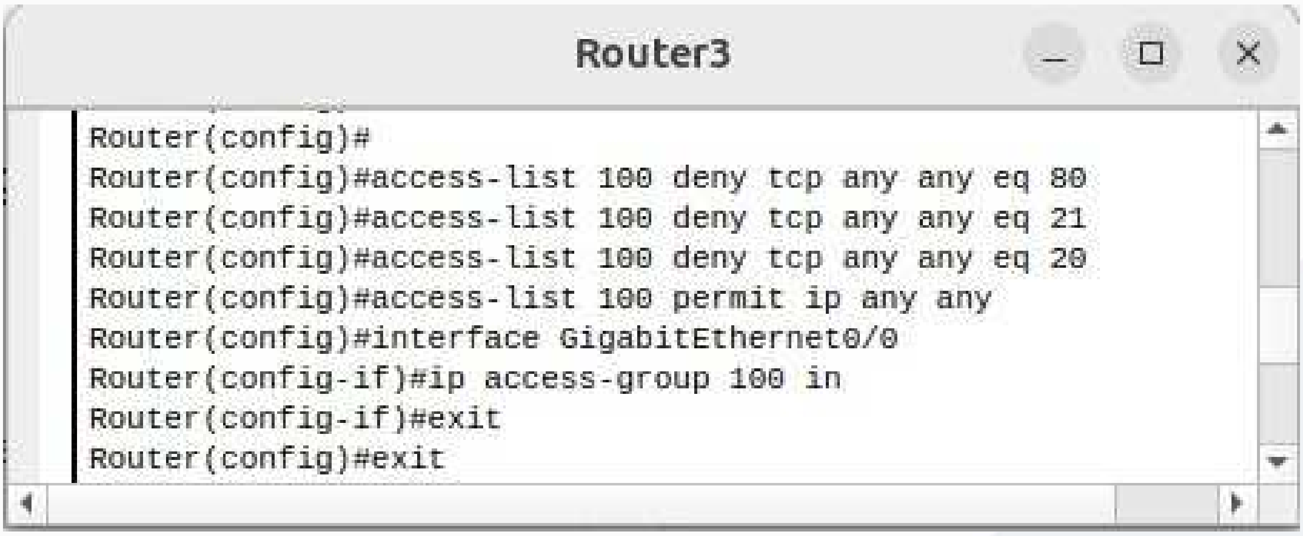
PC3 **success!**

PC5 **failed!**

13 Permissions:

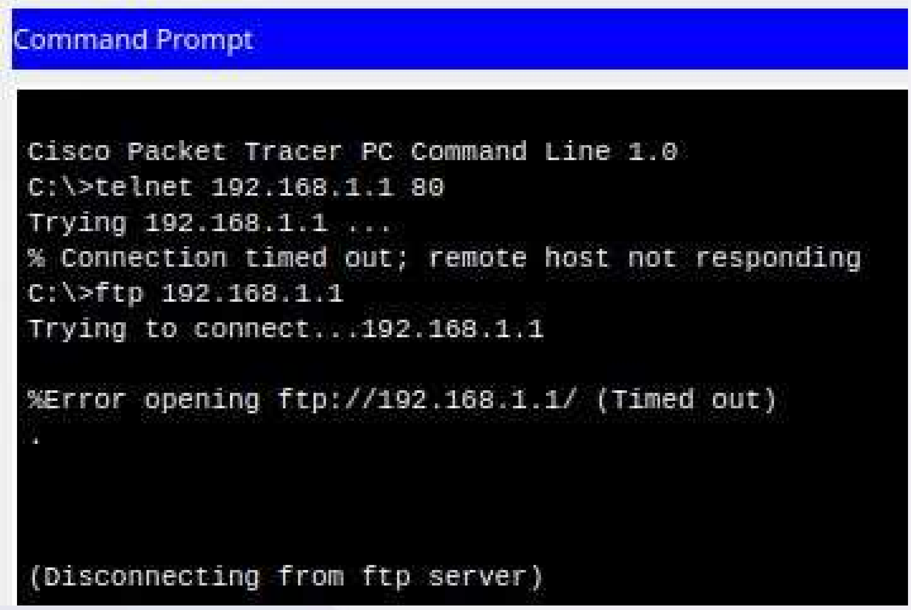
- Allowing the HTTP Port:
  - **access-list 100 deny tcp any any eq 80**
- Allowing the FTP Port - Data Transfer:
  - **access-list 100 deny tcp any any eq 20**
- Allowing the FTP Port - Control Channel:
  - **access-list 100 deny tcp any any eq 21**

Router Configuration:



```
Router(config)#
Router(config)#access-list 100 deny tcp any any eq 80
Router(config)#access-list 100 deny tcp any any eq 21
Router(config)#access-list 100 deny tcp any any eq 20
Router(config)#access-list 100 permit ip any any
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip access-group 100 in
Router(config-if)#exit
Router(config)#exit
```

Results after updating the permission:



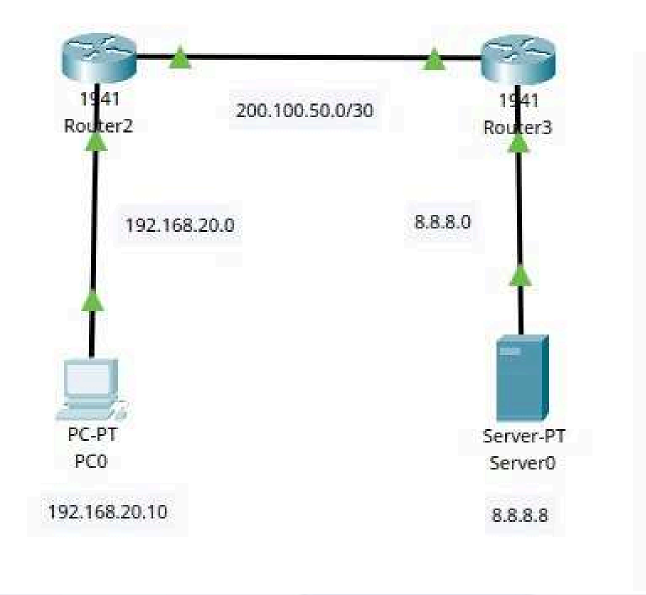
```
Cisco Packet Tracer PC Command Line 1.0
C:\>telnet 192.168.1.1 80
Trying 192.168.1.1 ...
% Connection timed out; remote host not responding
C:\>ftp 192.168.1.1
Trying to connect...192.168.1.1

%Error opening ftp://192.168.1.1/ (Timed out)
.



(Disconnecting from ftp server)
```

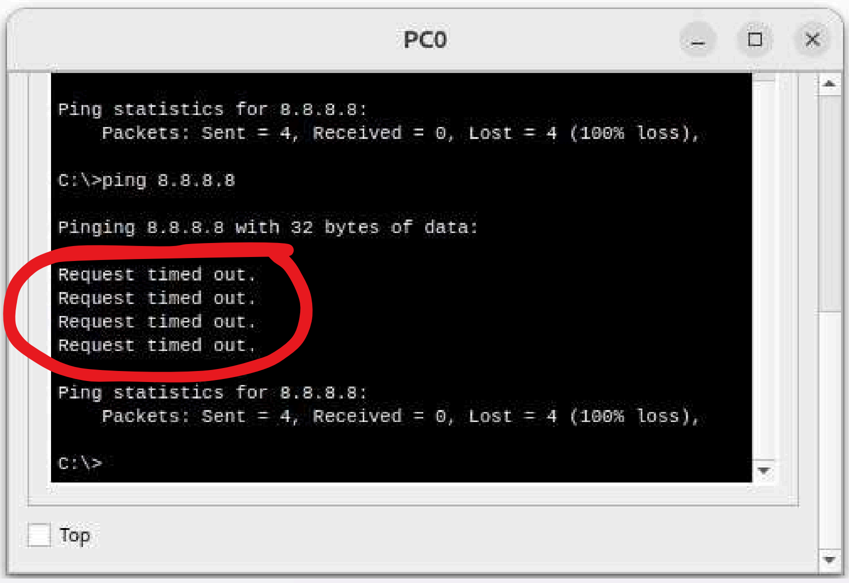
Qn 14:

Network Address Translation Task

NAT configuration:

- I started by creating a small network with a PC, two routers and a server
- Here are the IP configurations:
    - PC: **192.168.20.10**
    - Server: **8.8.8.8**
- I allowed the routers to trunk
- I configured NAT inside and NAT outside
- Router inside IP:
    - PC - Router1: **192.168.20.1**
    - Router1 - Router 2: **200.100.50.1**
- Router outside IP:
    - Router 1 - Router2: **200.100.50.2**
    - Router2 - Server: **8.8.8.1**
- I tried several attempts to solve this and configured the final network.
- I can’t access the server

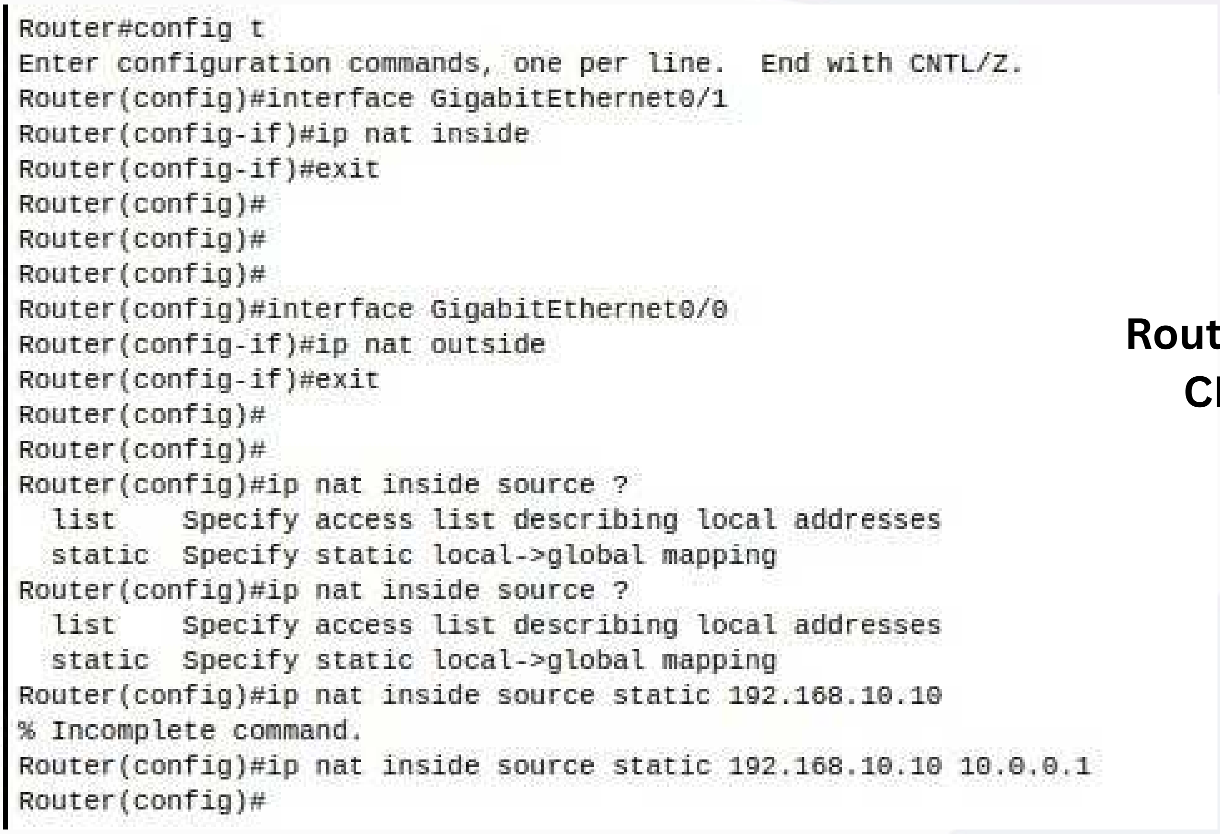




```
Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 8.8.8.8

Pinging 8.8.8.8 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

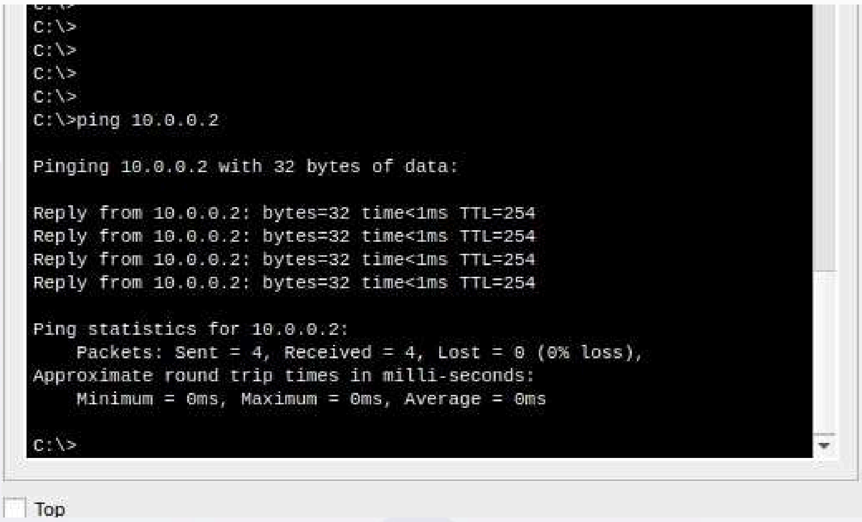
Actual Network:

- There was a problem in between as I couldn’t reach Router 2 from **PC1**
- I tried debugging through Router’s CLI and PC1's Command prompt
- Configured
    - **IP NAT Inside**
    - **IP NAT Outside**

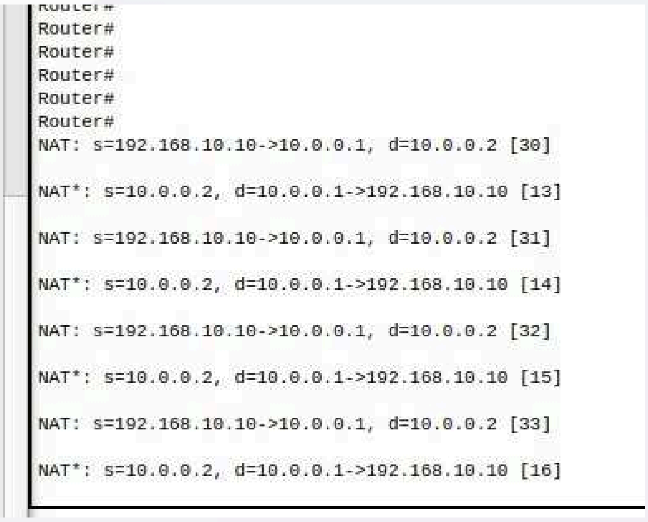


```
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface GigabitEthernet0/1
Router(config-if)#ip nat inside
Router(config-if)#exit
Router(config)#
Router(config)#
Router(config)#
Router(config)#interface GigabitEthernet0/0
Router(config-if)#ip nat outside
Router(config-if)#exit
Router(config)#
Router(config)#
Router(config)#ip nat inside source ?
  list    Specify access list describing local addresses
  static  Specify static local->global mapping
Router(config)#ip nat inside source ?
  list    Specify access list describing local addresses
  static  Specify static local->global mapping
Router(config)#ip nat inside source static 192.168.10.10
% Incomplete command.
Router(config)#ip nat inside source static 192.168.10.10 10.0.0.1
Router(config)#
```

Router’s CLI



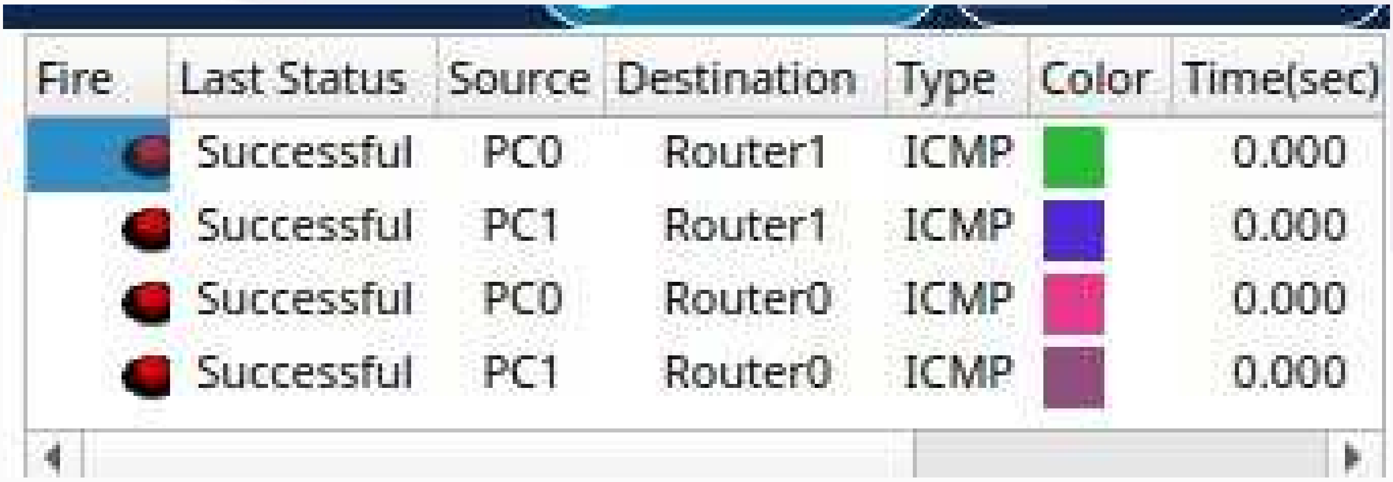
```
C:\>
C:\>
C:\>
C:\>
C:\>ping 10.0.0.2

Pinging 10.0.0.2 with 32 bytes of data:

Reply from 10.0.0.2: bytes=32 time<1ms TTL=254
Reply from 10.0.0.2: bytes=32 time<1ms TTL=254
Reply from 10.0.0.2: bytes=32 time<1ms TTL=254
Reply from 10.0.0.2: bytes=32 time<1ms TTL=254

Ping statistics for 10.0.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```



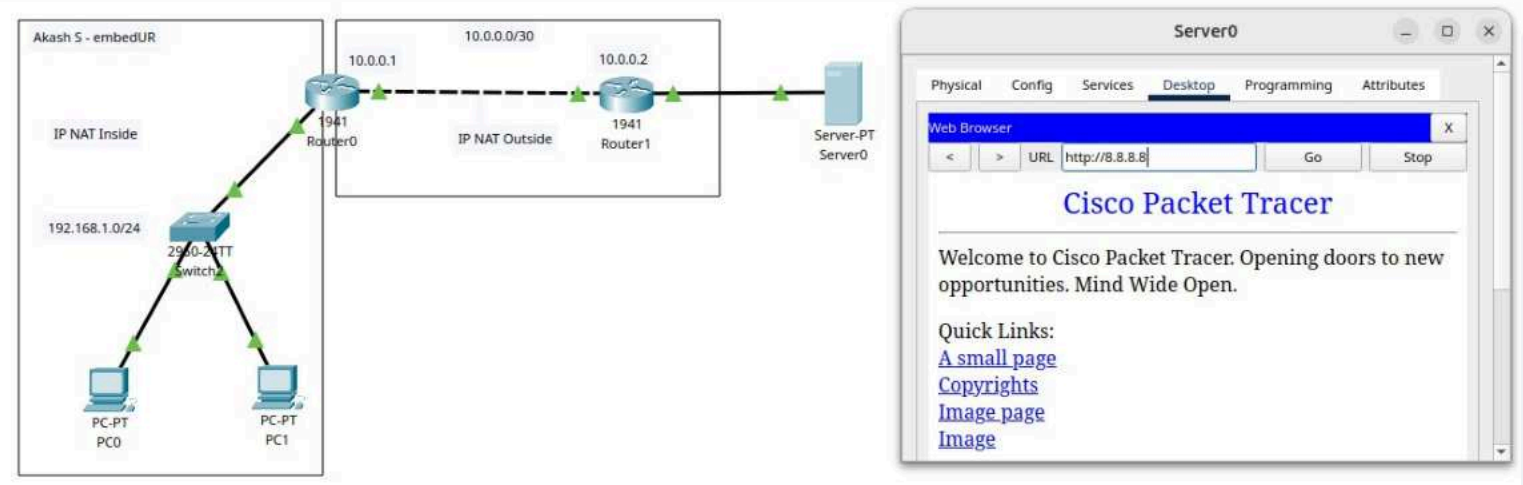
```
Router#
Router#
Router#
Router#
Router#
NAT: s=192.168.10.10->10.0.0.1, d=10.0.0.2 [30]

NAT*: s=10.0.0.2, d=10.0.0.1->192.168.10.10 [13]

NAT: s=192.168.10.10->10.0.0.1, d=10.0.0.2 [31]

NAT*: s=10.0.0.2, d=10.0.0.1->192.168.10.10 [14]

NAT: s=192.168.10.10->10.0.0.1, d=10.0.0.2 [32]

NAT*: s=10.0.0.2, d=10.0.0.1->192.168.10.10 [15]

NAT: s=192.168.10.10->10.0.0.1, d=10.0.0.2 [33]

NAT*: s=10.0.0.2, d=10.0.0.1->192.168.10.10 [16]
```

Results:

- I can now connect to the Web Server
- Google.com / 8.8.8.8



Fire	Last Status	Source	Destination	Type	Color	Time(sec)
●	Successful	PC0	Router1	ICMP	🟩	0.000
●	Successful	PC1	Router1	ICMP	🟦	0.000
●	Successful	PC0	Router0	ICMP	🟥	0.000
●	Successful	PC1	Router0	ICMP	🟪	0.000

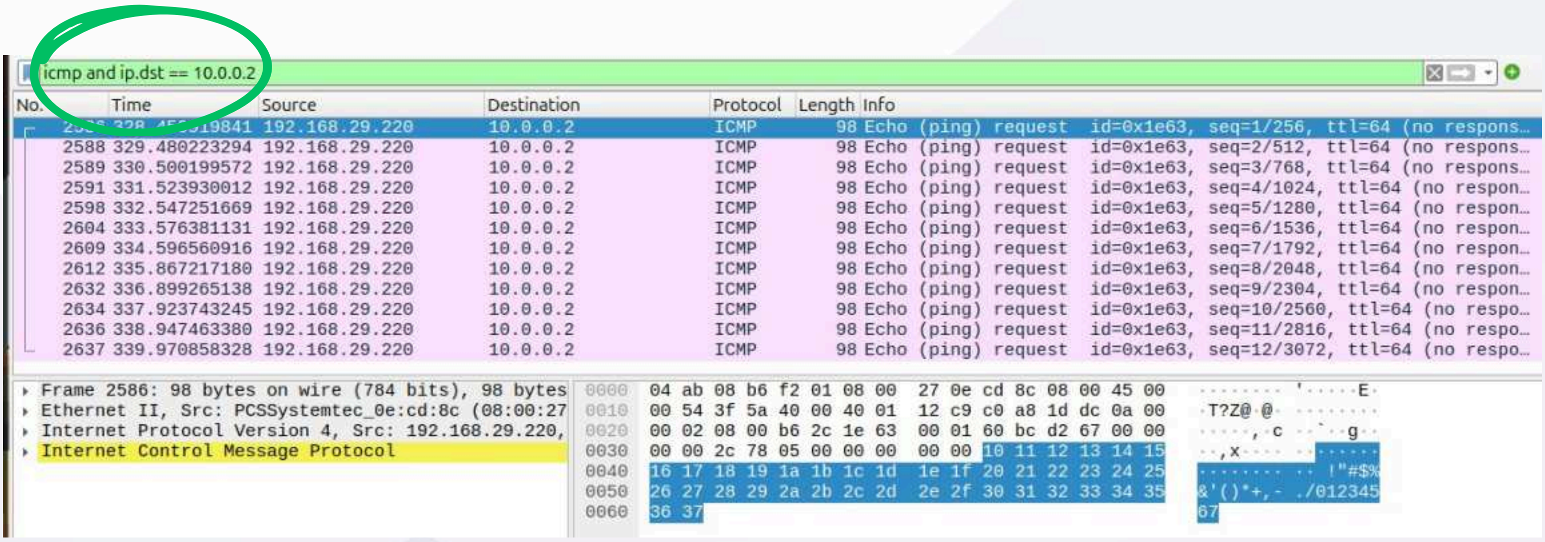


URL http://8.8.8.8

Cisco Packet Tracer

Welcome to Cisco Packet Tracer. Opening doors to new opportunities. Mind Wide Open.

Quick Links:
A small page
Copyrights
Image page
Image



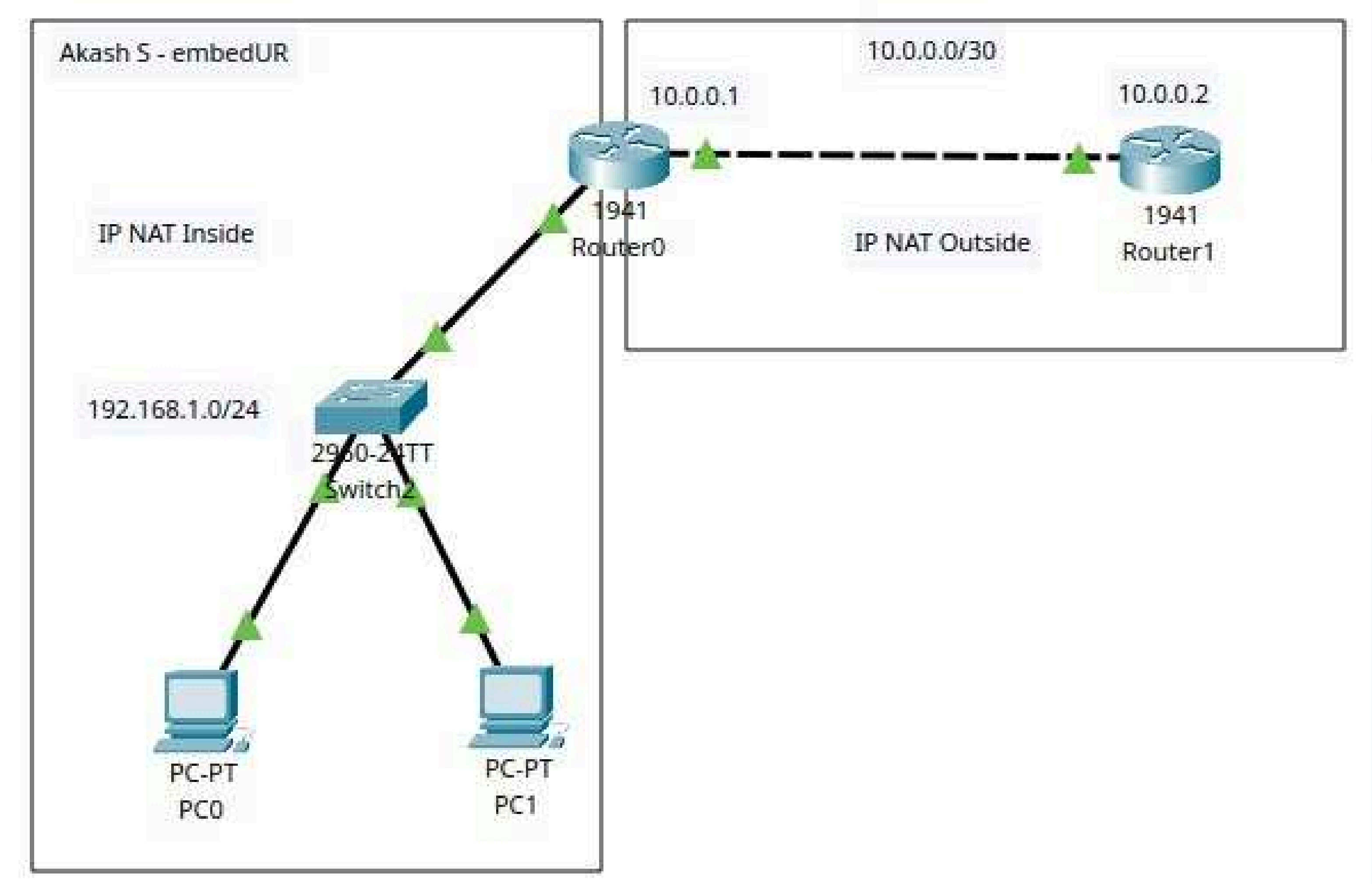
icmp and ip.dst == 10.0.0.2

```
No.  Time          Source          Destination  Protocol  Length Info
25[illegible] 328.45[illegible]19841 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=1/256, ttl=64 (no respons…
2588 329.480223294 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=2/512, ttl=64 (no respons…
2589 330.500199572 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=3/768, ttl=64 (no respons…
2591 331.523930012 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=4/1024, ttl=64 (no respon…
2598 332.547251669 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=5/1280, ttl=64 (no respon…
2604 333.576381131 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=6/1536, ttl=64 (no respon…
2609 334.596560916 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=7/1792, ttl=64 (no respon…
2612 335.867217180 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=8/2048, ttl=64 (no respon…
2632 336.899265138 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=9/2304, ttl=64 (no respon…
2634 337.923743245 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=10/2560, ttl=64 (no respo…
2636 338.947463380 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=11/2816, ttl=64 (no respo…
2637 339.970858328 192.168.29.220  10.0.0.2  ICMP  98 Echo (ping) request  id=0x1e63, seq=12/3072, ttl=64 (no respo…
```

```
▸ Frame 2586: 98 bytes on wire (784 bits), 98 bytes
▸ Ethernet II, Src: PCSSystemtec_0e:cd:8c (08:00:27
▸ Internet Protocol Version 4, Src: 192.168.29.220,
▸ Internet Control Message Protocol
```

```
0000  04 ab 08 b6 f2 01 08 00  27 0e cd 8c 08 00 45 00   ········ '·····E·
0010  00 54 3f 5a 40 00 40 01  12 c9 c0 a8 1d dc 0a 00   ·T?Z@·@· ········
0020  00 02 08 00 b6 2c 1e 63  00 01 60 bc d2 67 00 00   ·····,·c ··`··g··
0030  00 00 2c 78 05 00 00 00  00 00 10 11 12 13 14 15   ··,x···· ········
0040  16 17 18 19 1a 1b 1c 1d  1e 1f 20 21 22 23 24 25   ········ ·· !"#$%
0050  26 27 28 29 2a 2b 2c 2d  2e 2f 30 31 32 33 34 35   &'()*+,- ./012345
0060  36 37                                              67
```

Network Topology:



NAT inside and NAT outside

Qn 15:

Download iperf in laptop/phone and make sure they are in same network. Try different iperf commands with tcp, udp, birectional, reverse, multicast, parallel options and analyze the bandwidth and rate of transmission, delay, jitter etc

iperf:

- Iperf is a network performance testing tool that measures bandwidth, latency, jitter, and packet loss for TCP and UDP connections. It helps analyze network speed and performance under different conditions.

How iperf works?

- iPerf works in a client-server model. One device runs as a server (listening for connections), while another acts as a client (sending data).
- It supports TCP and UDP testing, bidirectional traffic, reverse mode, and parallel streams to simulate real-world network conditions.
- In my case, I tested everything within VirtualBox using localhost (127.0.0.1) instead of two separate devices.

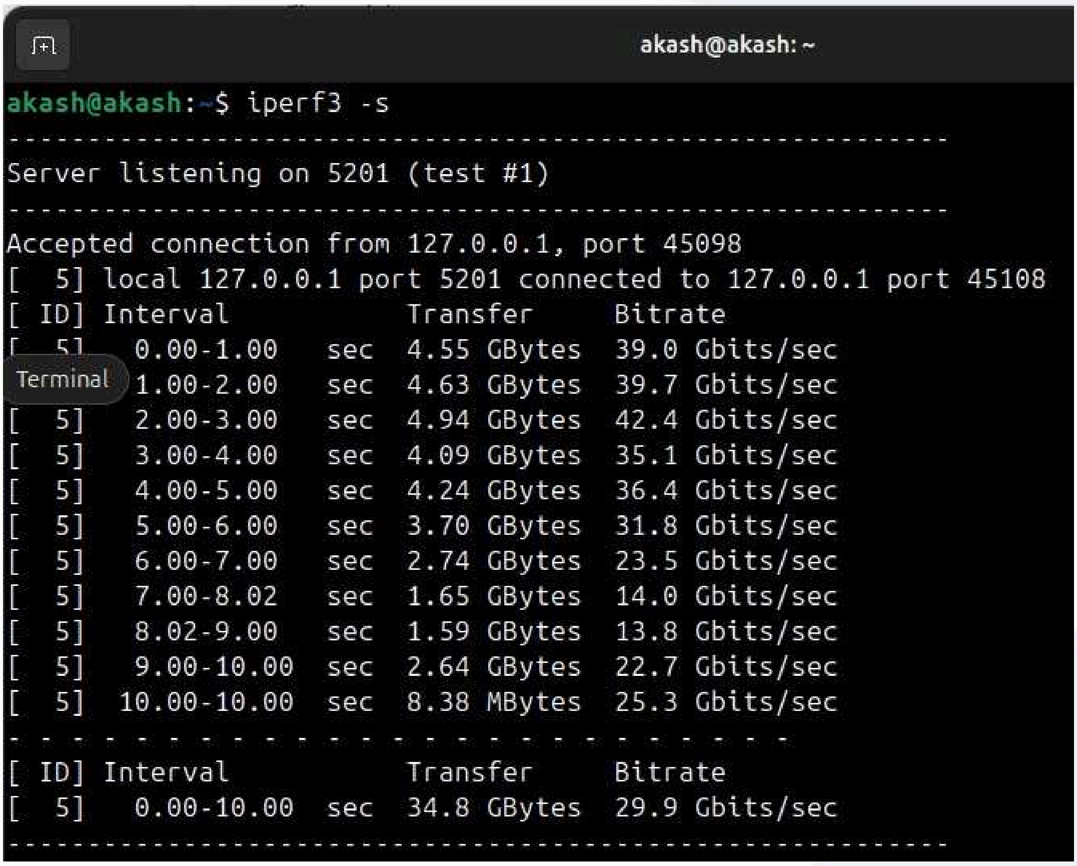
Commands I used:

- Starting iperf3 server:
  - **iperf3 -s**
- Running a TCP client mode:
  - **iperf3 -c 127.0.0.1**
- Running a UDP server:
  - **iperf3 -c 127.0.0.1 -u -b 10M**

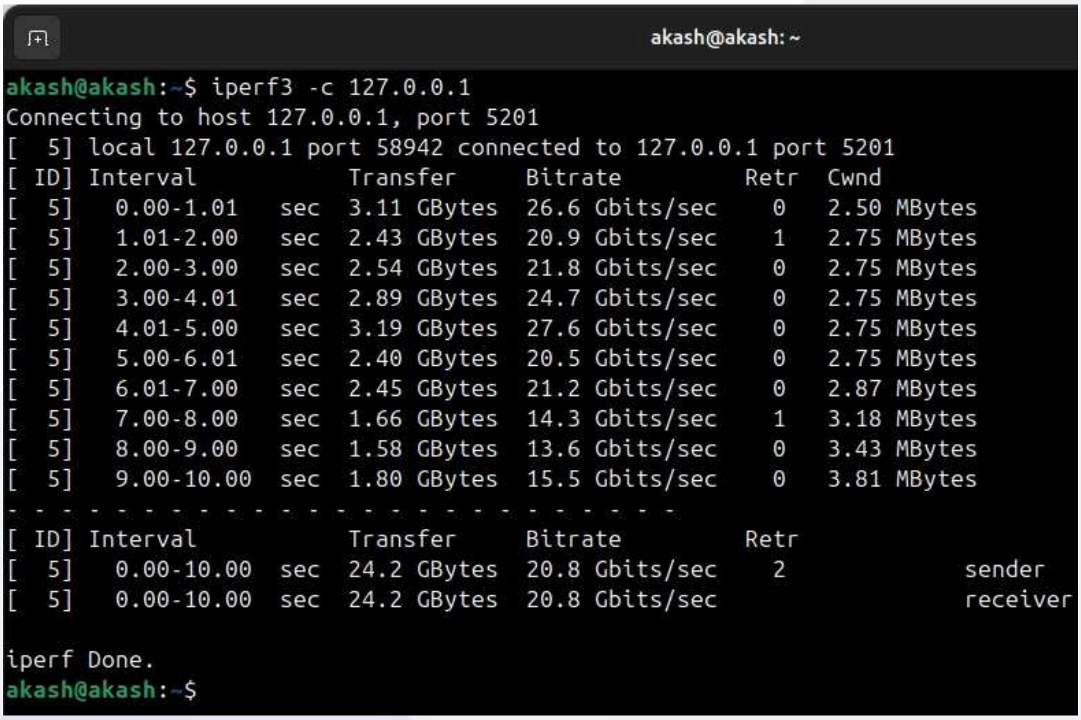
- Bidirectional Test:
    - **iperf3 -c 127.0.0.1 --bidir**
- Reverse Test:
    - **iperf3 -c 127.0.0.1 -R**
- Parallel Streams Test:
    - **iperf3 -c 127.0.0.1 -P 5**

Results:

TCP Client

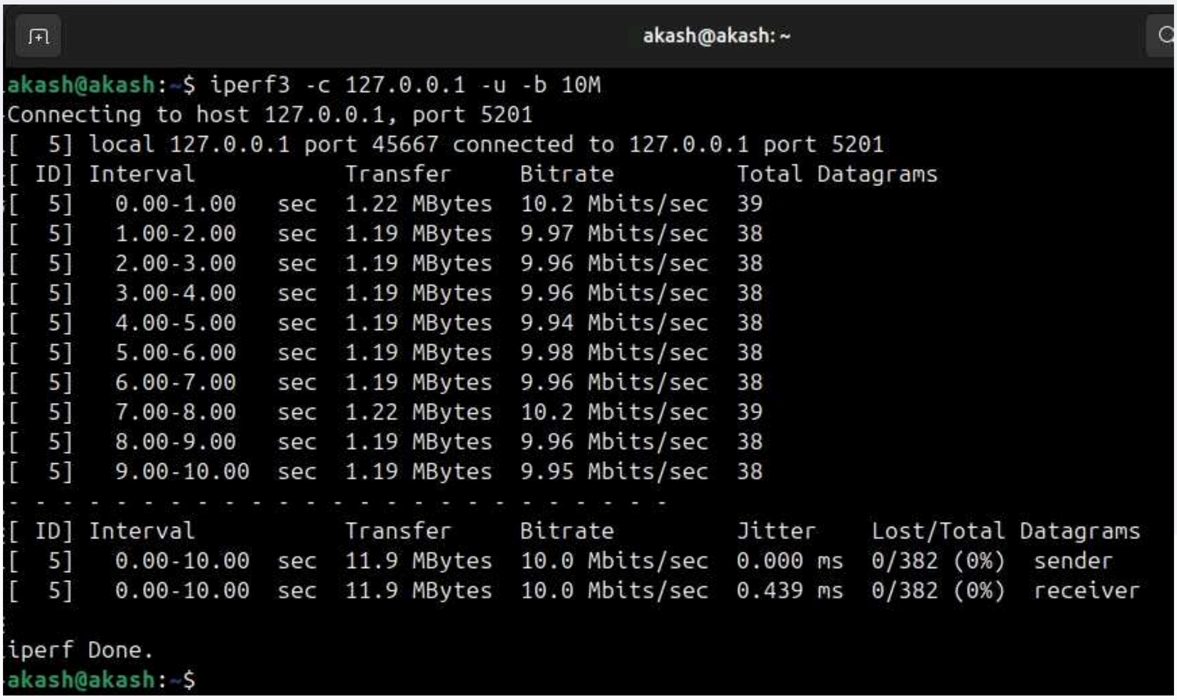


```
akash@akash:~$ iperf3 -s
-----------------------------------------------------------
Server listening on 5201 (test #1)
-----------------------------------------------------------
Accepted connection from 127.0.0.1, port 45098
[  5] local 127.0.0.1 port 5201 connected to 127.0.0.1 port 45108
[ ID] Interval           Transfer     Bitrate
[  5]   0.00-1.00   sec  4.55 GBytes  39.0 Gbits/sec
[  5]   1.00-2.00   sec  4.63 GBytes  39.7 Gbits/sec
[  5]   2.00-3.00   sec  4.94 GBytes  42.4 Gbits/sec
[  5]   3.00-4.00   sec  4.09 GBytes  35.1 Gbits/sec
[  5]   4.00-5.00   sec  4.24 GBytes  36.4 Gbits/sec
[  5]   5.00-6.00   sec  3.70 GBytes  31.8 Gbits/sec
[  5]   6.00-7.00   sec  2.74 GBytes  23.5 Gbits/sec
[  5]   7.00-8.02   sec  1.65 GBytes  14.0 Gbits/sec
[  5]   8.02-9.00   sec  1.59 GBytes  13.8 Gbits/sec
[  5]   9.00-10.00  sec  2.64 GBytes  22.7 Gbits/sec
[  5]  10.00-10.00  sec  8.38 MBytes  25.3 Gbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate
[  5]   0.00-10.00  sec  34.8 GBytes  29.9 Gbits/sec
-----------------------------------------------------------
```



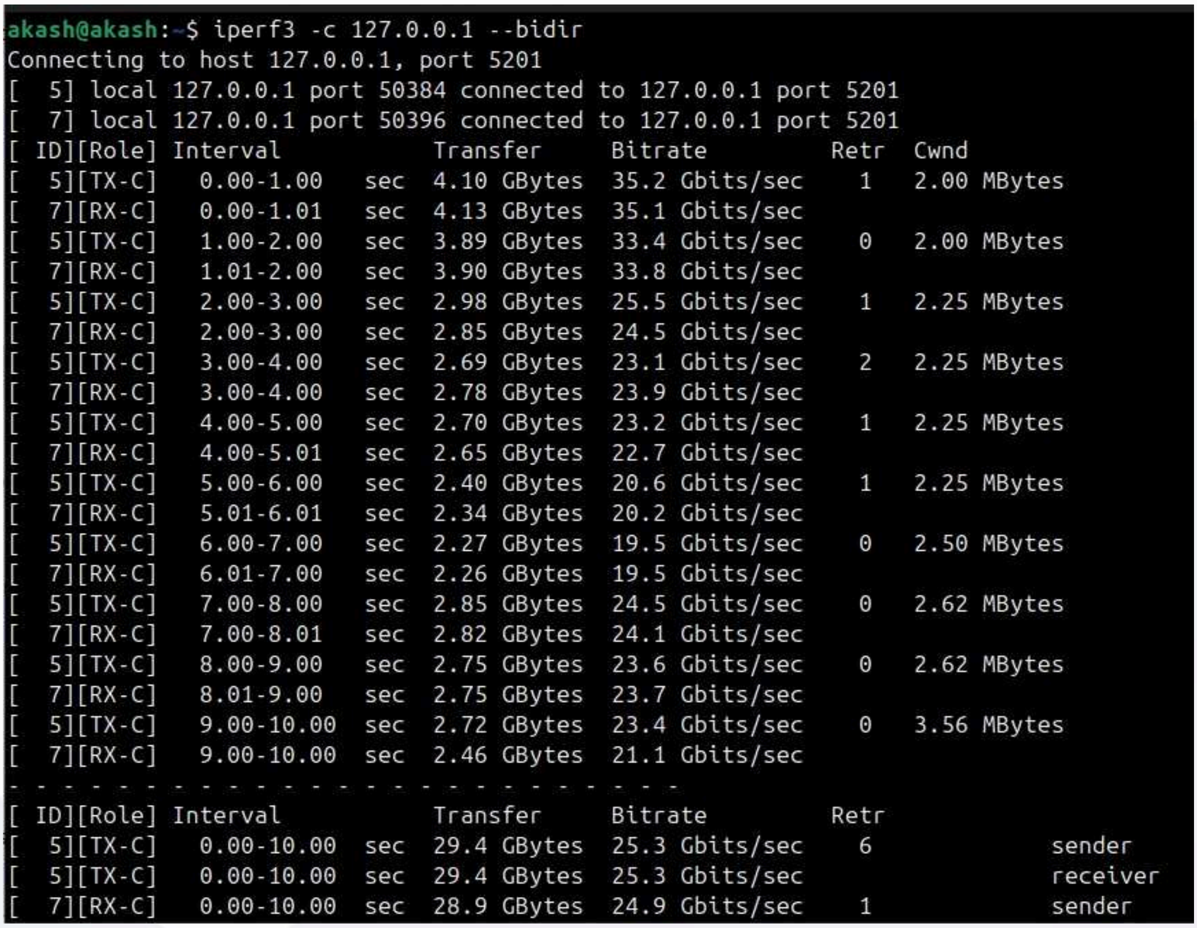
```
akash@akash:~$ iperf3 -c 127.0.0.1
Connecting to host 127.0.0.1, port 5201
[  5] local 127.0.0.1 port 58942 connected to 127.0.0.1 port 5201
[ ID] Interval           Transfer     Bitrate         Retr  Cwnd
[  5]   0.00-1.01   sec  3.11 GBytes  26.6 Gbits/sec    0   2.50 MBytes
[  5]   1.01-2.00   sec  2.43 GBytes  20.9 Gbits/sec    1   2.75 MBytes
[  5]   2.00-3.00   sec  2.54 GBytes  21.8 Gbits/sec    0   2.75 MBytes
[  5]   3.00-4.01   sec  2.89 GBytes  24.7 Gbits/sec    0   2.75 MBytes
[  5]   4.01-5.00   sec  3.19 GBytes  27.6 Gbits/sec    0   2.75 MBytes
[  5]   5.00-6.01   sec  2.40 GBytes  20.5 Gbits/sec    0   2.75 MBytes
[  5]   6.01-7.00   sec  2.45 GBytes  21.2 Gbits/sec    0   2.87 MBytes
[  5]   7.00-8.00   sec  1.66 GBytes  14.3 Gbits/sec    1   3.18 MBytes
[  5]   8.00-9.00   sec  1.58 GBytes  13.6 Gbits/sec    0   3.43 MBytes
[  5]   9.00-10.00  sec  1.80 GBytes  15.5 Gbits/sec    0   3.81 MBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate         Retr
[  5]   0.00-10.00  sec  24.2 GBytes  20.8 Gbits/sec    2             sender
[  5]   0.00-10.00  sec  24.2 GBytes  20.8 Gbits/sec                  receiver

iperf Done.
akash@akash:~$
```

UDP Server:



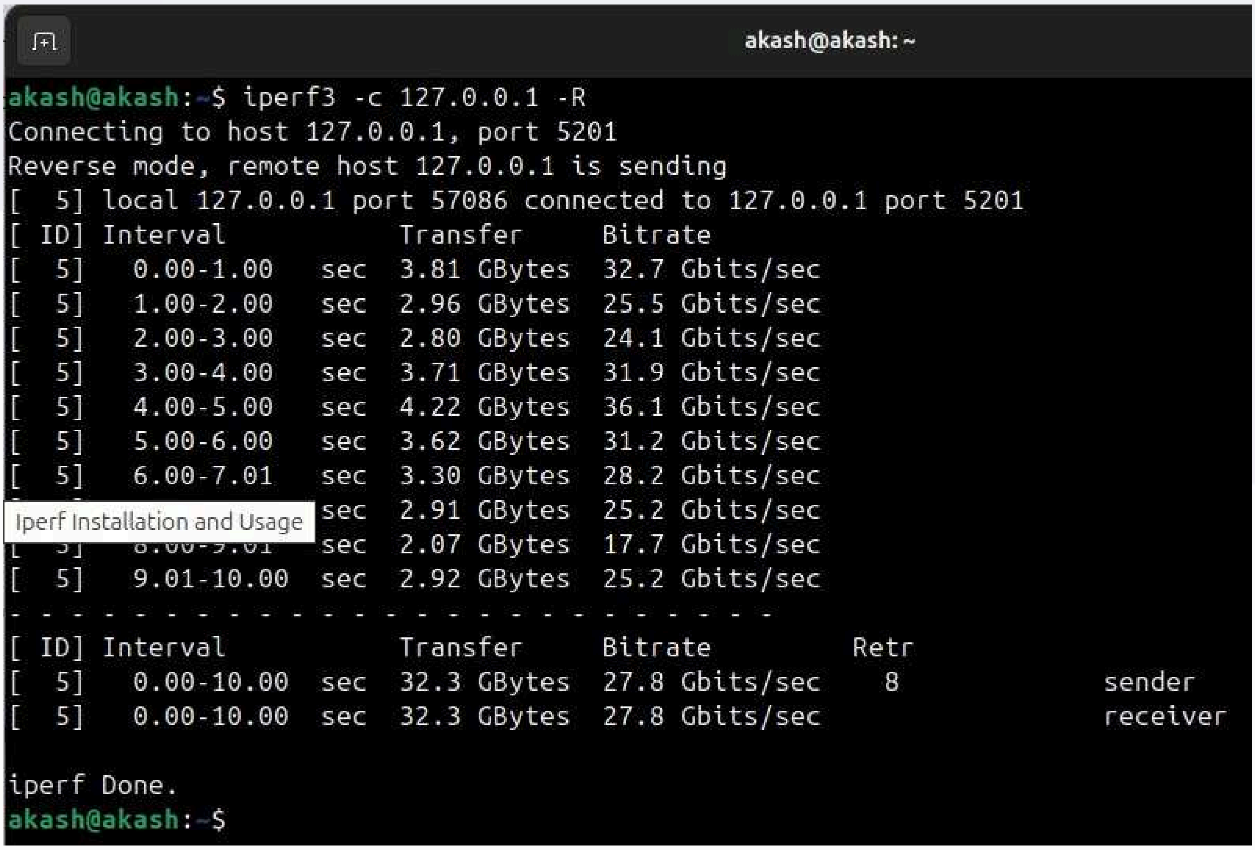
```
akash@akash:~$ iperf3 -c 127.0.0.1 -u -b 10M
Connecting to host 127.0.0.1, port 5201
[  5] local 127.0.0.1 port 45667 connected to 127.0.0.1 port 5201
[ ID] Interval           Transfer     Bitrate         Total Datagrams
[  5]   0.00-1.00   sec  1.22 MBytes  10.2 Mbits/sec  39
[  5]   1.00-2.00   sec  1.19 MBytes  9.97 Mbits/sec  38
[  5]   2.00-3.00   sec  1.19 MBytes  9.96 Mbits/sec  38
[  5]   3.00-4.00   sec  1.19 MBytes  9.96 Mbits/sec  38
[  5]   4.00-5.00   sec  1.19 MBytes  9.94 Mbits/sec  38
[  5]   5.00-6.00   sec  1.19 MBytes  9.98 Mbits/sec  38
[  5]   6.00-7.00   sec  1.19 MBytes  9.96 Mbits/sec  38
[  5]   7.00-8.00   sec  1.22 MBytes  10.2 Mbits/sec  39
[  5]   8.00-9.00   sec  1.19 MBytes  9.96 Mbits/sec  38
[  5]   9.00-10.00  sec  1.19 MBytes  9.95 Mbits/sec  38
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams
[  5]   0.00-10.00  sec  11.9 MBytes  10.0 Mbits/sec  0.000 ms  0/382 (0%)  sender
[  5]   0.00-10.00  sec  11.9 MBytes  10.0 Mbits/sec  0.439 ms  0/382 (0%)  receiver

iperf Done.
akash@akash:~$
```

Bidirectional:



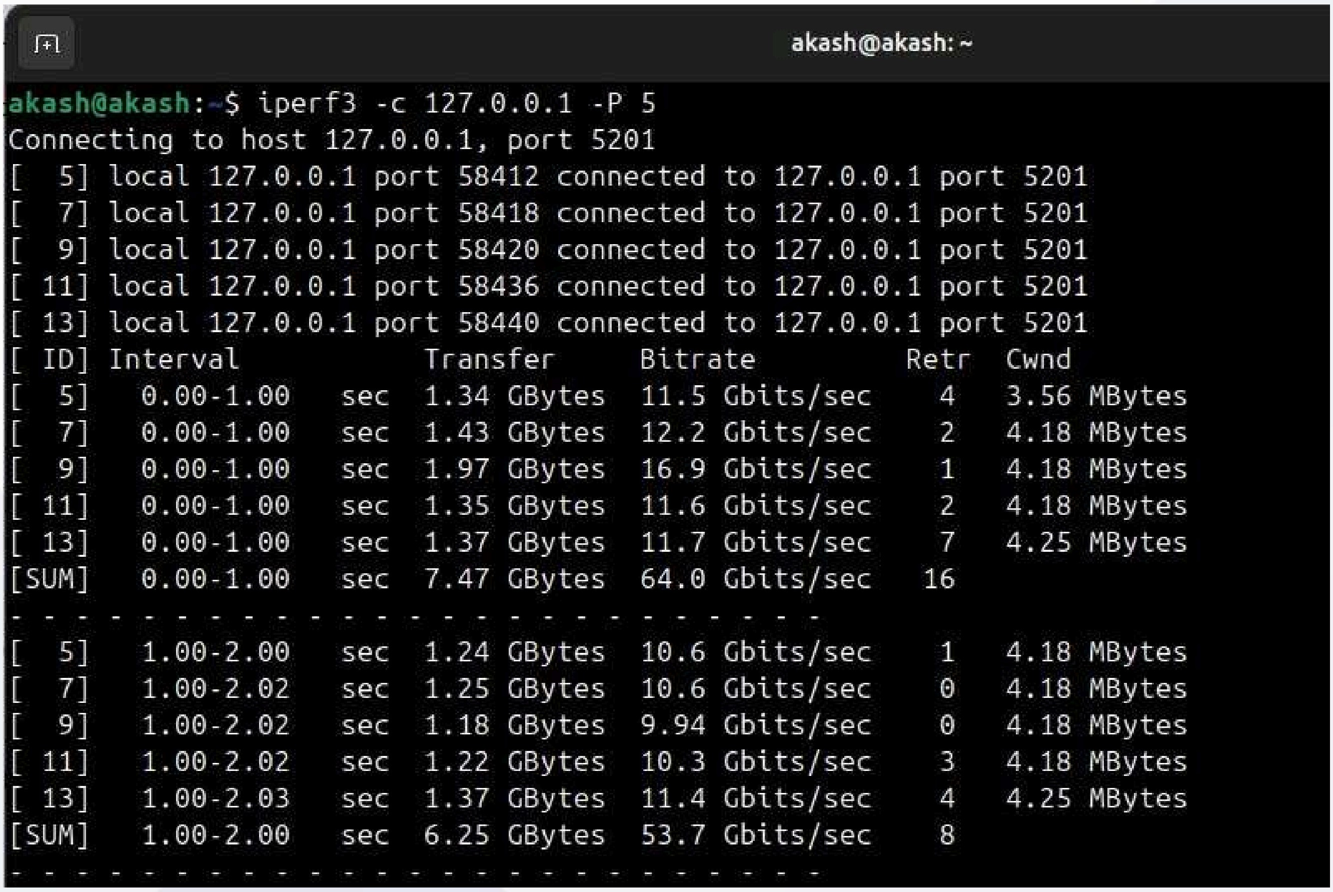
```
akash@akash:~$ iperf3 -c 127.0.0.1 --bidir
Connecting to host 127.0.0.1, port 5201
[  5] local 127.0.0.1 port 50384 connected to 127.0.0.1 port 5201
[  7] local 127.0.0.1 port 50396 connected to 127.0.0.1 port 5201
[ ID][Role] Interval           Transfer     Bitrate         Retr  Cwnd
[  5][TX-C]   0.00-1.00   sec  4.10 GBytes  35.2 Gbits/sec    1   2.00 MBytes
[  7][RX-C]   0.00-1.01   sec  4.13 GBytes  35.1 Gbits/sec
[  5][TX-C]   1.00-2.00   sec  3.89 GBytes  33.4 Gbits/sec    0   2.00 MBytes
[  7][RX-C]   1.01-2.00   sec  3.90 GBytes  33.8 Gbits/sec
[  5][TX-C]   2.00-3.00   sec  2.98 GBytes  25.5 Gbits/sec    1   2.25 MBytes
[  7][RX-C]   2.00-3.00   sec  2.85 GBytes  24.5 Gbits/sec
[  5][TX-C]   3.00-4.00   sec  2.69 GBytes  23.1 Gbits/sec    2   2.25 MBytes
[  7][RX-C]   3.00-4.00   sec  2.78 GBytes  23.9 Gbits/sec
[  5][TX-C]   4.00-5.00   sec  2.70 GBytes  23.2 Gbits/sec    1   2.25 MBytes
[  7][RX-C]   4.00-5.01   sec  2.65 GBytes  22.7 Gbits/sec
[  5][TX-C]   5.00-6.00   sec  2.40 GBytes  20.6 Gbits/sec    1   2.25 MBytes
[  7][RX-C]   5.01-6.01   sec  2.34 GBytes  20.2 Gbits/sec
[  5][TX-C]   6.00-7.00   sec  2.27 GBytes  19.5 Gbits/sec    0   2.50 MBytes
[  7][RX-C]   6.01-7.00   sec  2.26 GBytes  19.5 Gbits/sec
[  5][TX-C]   7.00-8.00   sec  2.85 GBytes  24.5 Gbits/sec    0   2.62 MBytes
[  7][RX-C]   7.00-8.01   sec  2.82 GBytes  24.1 Gbits/sec
[  5][TX-C]   8.00-9.00   sec  2.75 GBytes  23.6 Gbits/sec    0   2.62 MBytes
[  7][RX-C]   8.01-9.00   sec  2.75 GBytes  23.7 Gbits/sec
[  5][TX-C]   9.00-10.00  sec  2.72 GBytes  23.4 Gbits/sec    0   3.56 MBytes
[  7][RX-C]   9.00-10.00  sec  2.46 GBytes  21.1 Gbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID][Role] Interval           Transfer     Bitrate         Retr
[  5][TX-C]   0.00-10.00  sec  29.4 GBytes  25.3 Gbits/sec    6             sender
[  5][TX-C]   0.00-10.00  sec  29.4 GBytes  25.3 Gbits/sec                  receiver
[  7][RX-C]   0.00-10.00  sec  28.9 GBytes  24.9 Gbits/sec    1             sender
```

Reverse Test:



```
akash@akash:~$ iperf3 -c 127.0.0.1 -R
Connecting to host 127.0.0.1, port 5201
Reverse mode, remote host 127.0.0.1 is sending
[  5] local 127.0.0.1 port 57086 connected to 127.0.0.1 port 5201
[ ID] Interval           Transfer     Bitrate
[  5]   0.00-1.00   sec  3.81 GBytes  32.7 Gbits/sec
[  5]   1.00-2.00   sec  2.96 GBytes  25.5 Gbits/sec
[  5]   2.00-3.00   sec  2.80 GBytes  24.1 Gbits/sec
[  5]   3.00-4.00   sec  3.71 GBytes  31.9 Gbits/sec
[  5]   4.00-5.00   sec  4.22 GBytes  36.1 Gbits/sec
[  5]   5.00-6.00   sec  3.62 GBytes  31.2 Gbits/sec
[  5]   6.00-7.01   sec  3.30 GBytes  28.2 Gbits/sec
Iperf Installation and Usage sec  2.91 GBytes  25.2 Gbits/sec
[  5]   8.00-9.01   sec  2.07 GBytes  17.7 Gbits/sec
[  5]   9.01-10.00  sec  2.92 GBytes  25.2 Gbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate         Retr
[  5]   0.00-10.00  sec  32.3 GBytes  27.8 Gbits/sec    8             sender
[  5]   0.00-10.00  sec  32.3 GBytes  27.8 Gbits/sec                  receiver

iperf Done.
akash@akash:~$
```

Parallel Stream Test:



```
akash@akash:~$ iperf3 -c 127.0.0.1 -P 5
Connecting to host 127.0.0.1, port 5201
[  5] local 127.0.0.1 port 58412 connected to 127.0.0.1 port 5201
[  7] local 127.0.0.1 port 58418 connected to 127.0.0.1 port 5201
[  9] local 127.0.0.1 port 58420 connected to 127.0.0.1 port 5201
[ 11] local 127.0.0.1 port 58436 connected to 127.0.0.1 port 5201
[ 13] local 127.0.0.1 port 58440 connected to 127.0.0.1 port 5201
[ ID] Interval           Transfer     Bitrate         Retr  Cwnd
[  5]   0.00-1.00   sec  1.34 GBytes  11.5 Gbits/sec    4   3.56 MBytes
[  7]   0.00-1.00   sec  1.43 GBytes  12.2 Gbits/sec    2   4.18 MBytes
[  9]   0.00-1.00   sec  1.97 GBytes  16.9 Gbits/sec    1   4.18 MBytes
[ 11]   0.00-1.00   sec  1.35 GBytes  11.6 Gbits/sec    2   4.18 MBytes
[ 13]   0.00-1.00   sec  1.37 GBytes  11.7 Gbits/sec    7   4.25 MBytes
[SUM]   0.00-1.00   sec  7.47 GBytes  64.0 Gbits/sec   16
- - - - - - - - - - - - - - - - - - - - - - - - -
[  5]   1.00-2.00   sec  1.24 GBytes  10.6 Gbits/sec    1   4.18 MBytes
[  7]   1.00-2.02   sec  1.25 GBytes  10.6 Gbits/sec    0   4.18 MBytes
[  9]   1.00-2.02   sec  1.18 GBytes  9.94 Gbits/sec    0   4.18 MBytes
[ 11]   1.00-2.02   sec  1.22 GBytes  10.3 Gbits/sec    3   4.18 MBytes
[ 13]   1.00-2.03   sec  1.37 GBytes  11.4 Gbits/sec    4   4.25 MBytes
[SUM]   1.00-2.00   sec  6.25 GBytes  53.7 Gbits/sec    8
- - - - - - - - - - - - - - - - - - - - - - - - -
```

THE END

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