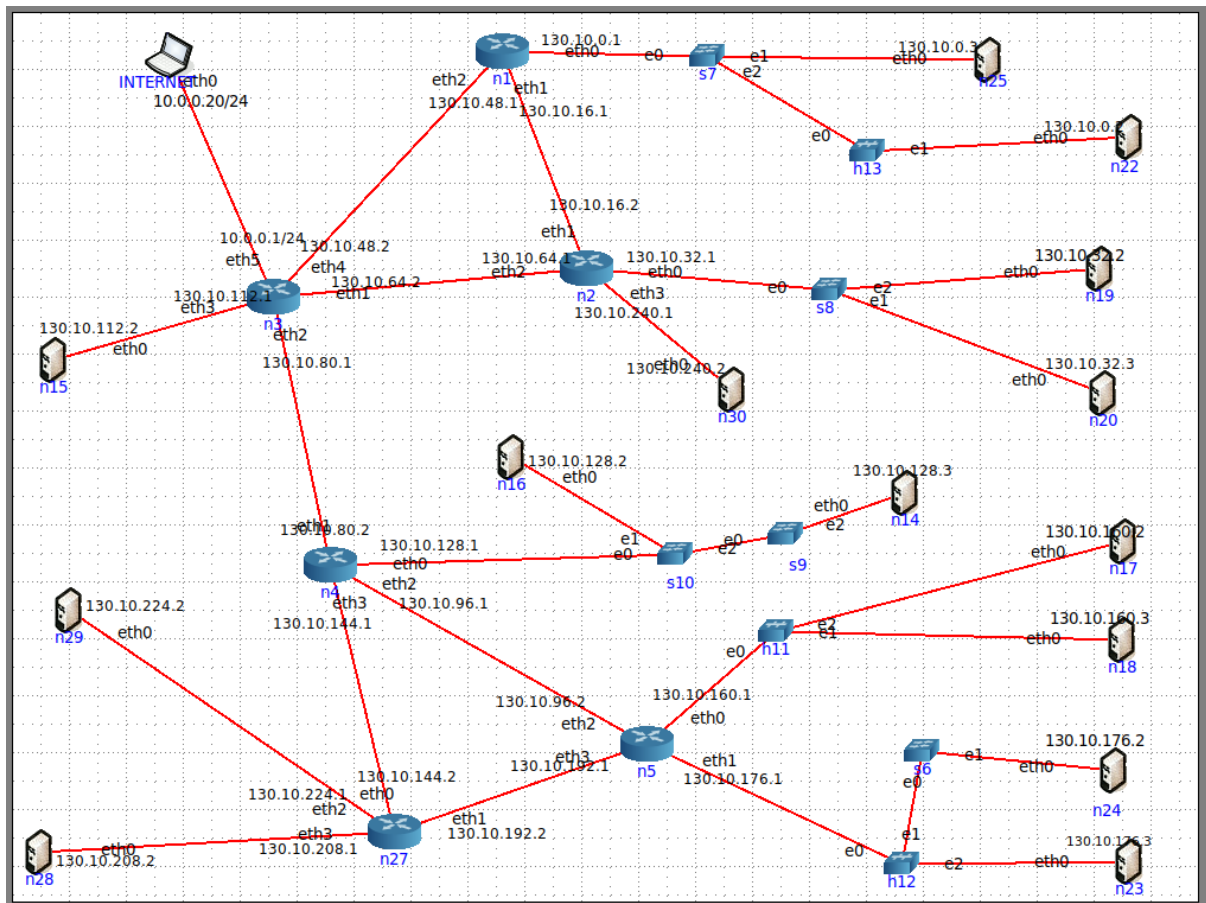


# Relatório Trabalho 1 - Laboratório de redes de computadores

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## 1. Topologia

Foi escolhida uma topologia com 16 endereços de sub-rede, todos foram utilizados, ficando com CIDR 130.10.0.0/20. Existe um total de 6 roteadores, 3 hubs, 5 switches 14 hosts e um ponto de conexão simulando uma conexão externa com a internet.



## 2. Ping

Na sequência de comandos a seguir é possível notar que a tabela arp está vazia no resultado do primeiro comando, depois é executado o comando de ping do nodo 25 para o nodo 23 e funciona corretamente, e então verificando a tabela arp novamente notamos que agora a tabela arp está preenchida com o endereço dos roteadores conectados em cada nodo.

```
vcmd (on corevm)
root@n25:/tmp/pycore.43113/n25.conf# ip neigh show dev eth0
root@n25:/tmp/pycore.43113/n25.conf# ping -c 3 130.10.176.3
PING 130.10.176.3 (130.10.176.3) 56(84) bytes of data:
64 bytes from 130.10.176.3: icmp_seq=1 ttl=60 time=0.647 ms
64 bytes from 130.10.176.3: icmp_seq=2 ttl=60 time=0.237 ms
64 bytes from 130.10.176.3: icmp_seq=3 ttl=60 time=0.347 ms

--- 130.10.176.3 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2030ms
rtt min/avg/max/mdev = 0.237/0.410/0.647/0.173 ms
root@n25:/tmp/pycore.43113/n25.conf# ip neigh show dev eth0
130.10.0.1 lladdr 00:00:00:aa:00:0c REACHABLE
root@n25:/tmp/pycore.43113/n25.conf#
```

```
vcmd (on corevm)
root@n23:/tmp/pycore.43113/n23.conf# ip neigh show dev eth0
root@n23:/tmp/pycore.43113/n23.conf# ip neigh show dev eth0
130.10.176.1 lladdr 00:00:00:aa:00:09 REACHABLE
root@n23:/tmp/pycore.43113/n23.conf#
```

Nas imagens a seguir estão os pacotes ARP e ICMP transferidos durante a execução do ping anterior, como a tabela desses nodos está vazia, os dois executam um broadcast para descobrir qual é o endereço MAC da máquina que o pacote será enviado, como o default do nodo 25 é o ip 130.10.0.1 ele tenta descobrir qual o Mac responsável por esse IP.

Depois são executados os comandos de envio do ping com o ICMP echo request e reply, as últimas linhas representam o retorno do ping, onde o roteador está tentando descobrir qual o Mac do IP 130.10.0.3, que é o nodo atual.

O cenário se repete parecido no nodo 23, porém com a ordem ao contrário, primeiro o roteador descobrindo o nodo por ARP e depois o nodo conhecendo o roteador.

The image shows a Wireshark packet capture window titled '\*veth19.0.c1 (on corevm)'. The filter is 'icmp || arp'. The packet list shows several ARP and ICMP packets. The packet details pane is expanded for packet 33, showing an Ethernet II frame with source 00:00:00:aa:00:0d and destination 00:00:00:aa:00:0c, containing an ARP (Type: 0x0806) packet. The packet bytes pane shows the raw data of the packet.

No.	Time	Source	Destination	Protocol	Length	Info
24	822.165029470	00:00:00:aa:00:0d	Broadcast	ARP	42	Who has 130.10.0.1? Tell 130.10.0.3
25	822.165211019	00:00:00:aa:00:0c	00:00:00:aa:00:0d	ARP	42	130.10.0.1 is at 00:00:00:aa:00:0c
26	822.165221273	130.10.0.3	130.10.176.3	ICMP	98	Echo (ping) request id=0x0034, seq=1/256, ttl=64 (reply in 2...
27	822.165622720	130.10.176.3	130.10.0.3	ICMP	98	Echo (ping) reply id=0x0034, seq=1/256, ttl=60 (request in...
28	823.168179575	130.10.0.3	130.10.176.3	ICMP	98	Echo (ping) request id=0x0034, seq=2/512, ttl=64 (reply in 2...
29	823.168351241	130.10.176.3	130.10.0.3	ICMP	98	Echo (ping) reply id=0x0034, seq=2/512, ttl=60 (request in...
30	824.194832983	130.10.0.3	130.10.176.3	ICMP	98	Echo (ping) request id=0x0034, seq=3/768, ttl=64 (reply in 3...
31	824.195112191	130.10.176.3	130.10.0.3	ICMP	98	Echo (ping) reply id=0x0034, seq=3/768, ttl=60 (request in...
32	827.394031170	00:00:00:aa:00:0c	00:00:00:aa:00:0d	ARP	42	Who has 130.10.0.3? Tell 130.10.0.1
33	827.394087631	00:00:00:aa:00:0c	00:00:00:aa:00:0d	ARP	42	130.10.0.3 is at 00:00:00:aa:00:0d

Frame 33: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface veth19.0.c1, id 0

Ethernet II, Src: 00:00:00:aa:00:0d (00:00:00:aa:00:0d), Dst: 00:00:00:aa:00:0c (00:00:00:aa:00:0c)

- Destination: 00:00:00:aa:00:0c (00:00:00:aa:00:0c)
- Source: 00:00:00:aa:00:0d (00:00:00:aa:00:0d)
- Type: ARP (0x0806)

Address Resolution Protocol (reply)

0000 00 00 00 aa 00 0c 00 00 00 aa 00 0d 08 06 00 01 .....  
0010 08 00 06 04 00 02 00 00 00 aa 00 0d 82 0a 00 03 .....  
0020 00 00 00 aa 00 0c 82 0a 00 01 .....

Ethernet (eth), 14 bytes      Packets: 39 · Displayed: 10 (25.6%)      Profile: Default

The image shows a Wireshark packet capture on the veth17.0.c1 interface. The filter is set to 'icmp || arp'. The capture shows several ARP requests and replies, followed by a series of ICMP Echo (ping) requests and replies. The first ping request is from 130.10.176.1 to 130.10.176.3 with ID 0x0034 and sequence 1. The subsequent replies are from 130.10.176.3 to 130.10.176.1 with the same ID and sequence. The packet details pane for frame 21 shows the Ethernet II header, Internet Protocol Version 4 header, and Internet Control Message Protocol header.

No.	Time	Source	Destination	Protocol	Length	Info
19	764.821524462	00:00:00_aa:00:09	Broadcast	ARP	42	Who has 130.10.176.3? Tell 130.10.176.1
20	764.821552909	00:00:00_aa:00:0b	00:00:00_aa:00:09	ARP	42	130.10.176.3 is at 00:00:00_aa:00:0b
21	764.821600575	130.10.0.3	130.10.176.3	ICMP	98	Echo (ping) request id=0x0034, seq=1/256, ttl=60 (reply in 2...
22	764.821626306	130.10.176.3	130.10.0.3	ICMP	98	Echo (ping) reply id=0x0034, seq=1/256, ttl=64 (request in...
23	765.824332319	130.10.0.3	130.10.176.3	ICMP	98	Echo (ping) request id=0x0034, seq=2/512, ttl=60 (reply in 2...
24	765.824365591	130.10.176.3	130.10.0.3	ICMP	98	Echo (ping) reply id=0x0034, seq=2/512, ttl=64 (request in...
25	766.850991073	130.10.0.3	130.10.176.3	ICMP	98	Echo (ping) request id=0x0034, seq=3/768, ttl=60 (reply in 2...
26	766.851037955	130.10.176.3	130.10.0.3	ICMP	98	Echo (ping) reply id=0x0034, seq=3/768, ttl=64 (request in...
27	770.050024762	00:00:00_aa:00:0b	00:00:00_aa:00:09	ARP	42	Who has 130.10.176.1? Tell 130.10.176.3
28	770.050206298	00:00:00_aa:00:09	00:00:00_aa:00:0b	ARP	42	130.10.176.1 is at 00:00:00_aa:00:09

Frame 21: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface veth17.0.c1, id 0  
 Ethernet II, Src: 00:00:00\_aa:00:09 (00:00:00\_aa:00:09), Dst: 00:00:00\_aa:00:0b (00:00:00\_aa:00:0b)  
 Internet Protocol Version 4, Src: 130.10.0.3, Dst: 130.10.176.3  
 Internet Control Message Protocol

```

0000  00 00 00 aa 00 0b 00 00 00 aa 00 09 08 00 45 00  ....E.
0010  00 54 e8 d4 40 00 3c 01 a1 b9 82 0a 00 03 82 0a  .T.@.<.
0020  b0 03 08 00 12 95 00 34 00 01 d4 de 38 64 00 00  ....4....8d.
0030  00 00 19 20 00 00 00 00 00 00 10 11 12 13 14 15  ....
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
  
```

Address Resolution Protocol: Protocol      Packets: 34 · Displayed: 10 (29.4%)      Profile: Default

### 3. Traceroute

O comando traceroute não estava funcionando corretamente no emulador, então encontrei o comando tracepath que funciona de maneira parecida, mas não igual

Ele usa o protocolo UDP e vai incrementando o TTL assim como traceroute

Execução do comando:

The image shows a terminal window titled 'vcmd (on corevm)'. The user is at the prompt 'root@n29:/tmp/pycore.43113/n29.conf#'. They enter the command 'tracepath 130.10.32.2'. The output shows the path from the local host to the destination IP 130.10.32.2. The path consists of 5 hops. The first hop is the local host. The subsequent hops show the IP addresses of the intermediate routers. The round-trip times for each hop are displayed in milliseconds. The final hop shows '0.213ms reached'.

```

root@n29:/tmp/pycore.43113/n29.conf# tracepath 130.10.32.2
1?: [LOCALHOST] pmtu 1500
 1: ??? 0.678ms
 1: ??? 0.107ms
 2: ??? 0.530ms
 3: ??? 0.159ms
 4: ??? 0.161ms
 5: ??? 0.213ms reached
Resume: pmtu 1500 hops 5 back 5
root@n29:/tmp/pycore.43113/n29.conf#
  
```

Na imagem abaixo na execução do tracpath, está destacado em azul na parte de baixo o time to live que a cada execução acontece o timeout e então o TTL é incrementado e uma nova requisição UDP é feita e na última imagem temos o TTL final 5 obtido ao descobrir o IP destino.

*veth1d.0.c1 (on corevm)					
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help					
Apply a display filter ... <Ctrl-/>					
No.	Time	Source	Destination	Protocol	Length Info
1	0.000000000	00:00:00 aa:00:22	Broadcast	ARP	42 Who has 130.10.224.1? Tell 130.10.224.2
2	0.000155426	00:00:00 aa:00:21	00:00:00 aa:00:22	ARP	42 130.10.224.1 is at 00:00:00:aa:00:21
3	0.000168685	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44444 Len=1472
4	0.000231376	130.10.224.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
5	0.003286744	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44445 Len=1472
6	0.003335221	130.10.224.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
7	0.003874206	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44446 Len=1472
8	0.004050578	130.10.144.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
9	0.004861778	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44447 Len=1472
10	0.004968275	130.10.80.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
11	0.005442092	130.10.224.2	130.10.32.2	WireGu...	1514 Transport Data, receiver=0x00000000, counter=1681451810, data...
12	0.005552450	130.10.64.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
13	0.006022246	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44449 Len=1472
14	0.006184796	130.10.32.2	130.10.224.2	ICMP	590 Destination unreachable (Port unreachable)
15	5.158469282	00:00:00 aa:00:21	00:00:00 aa:00:22	ARP	42 Who has 130.10.224.2? Tell 130.10.224.1
16	5.158502931	00:00:00 aa:00:22	00:00:00 aa:00:21	ARP	42 130.10.224.2 is at 00:00:00:aa:00:22
17	84.774749157	fe80::200:ff:feaa:22	ff02::2	ICMPv6	70 Router Solicitation from 00:00:00:aa:00:22

Internet Protocol Version 4, Src: 130.10.224.2, Dst: 130.10.32.2					
0100	....	= Version: 4			
....	0101	= Header Length: 20 bytes (5)			
▸	Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)				
Total Length: 1500					
Identification: 0x0000 (0)					
▸	Flags: 0x4000, Don't fragment				
Fragment offset: 0					
▸	Time to live: 1				
Protocol: UDP (17)					
Header checksum: 0x6ff8 [validation disabled]					
[Header checksum status: Unverified]					
Source: 130.10.224.2					
0000	00 00 00 aa 00 21	00 00 00 aa 00 22	08 00 45 00	..... .. ...".E-	
0010	05 dc 00 00 40 00 01 11	6f f8 82 0a e0 02 82 0a	....@... o.....		
0020	20 02 8c f5 ad 9d 05 c8	11 f2 01 00 00 00 00 00	....@... o.....		
0030	00 00 22 eb 38 64 00 00	00 00 45 70 02 00 00 00	...".8d... ..Ep....		
0040	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....		
0050	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....		
0060	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....		
0070	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....		
0080	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....		

3	0.000168685	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44444 Len=1472
4	0.000231376	130.10.224.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
5	0.003286744	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44445 Len=1472
6	0.003335221	130.10.224.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
7	0.003874206	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44446 Len=1472
8	0.004050578	130.10.144.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
9	0.004861778	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44447 Len=1472
10	0.004968275	130.10.80.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
11	0.005442092	130.10.224.2	130.10.32.2	WireGu...	1514 Transport Data, receiver=0x00000000, counter=1681451810, data...
12	0.005552450	130.10.64.1	130.10.224.2	ICMP	590 Time-to-live exceeded (Time to live exceeded in transit)
13	0.006022246	130.10.224.2	130.10.32.2	UDP	1514 36085 → 44449 Len=1472
14	0.006184796	130.10.32.2	130.10.224.2	ICMP	590 Destination unreachable (Port unreachable)
15	5.158469282	00:00:00 aa:00:21	00:00:00 aa:00:22	ARP	42 Who has 130.10.224.2? Tell 130.10.224.1
16	5.158502931	00:00:00 aa:00:22	00:00:00 aa:00:21	ARP	42 130.10.224.2 is at 00:00:00:aa:00:22
17	84.774749157	fe80::200:ff:feaa:22	ff02::2	ICMPv6	70 Router Solicitation from 00:00:00:aa:00:22

Internet Protocol Version 4, Src: 130.10.224.2, Dst: 130.10.32.2					
0100	....	= Version: 4			
....	0101	= Header Length: 20 bytes (5)			
▸	Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)				
Total Length: 1500					
Identification: 0x0000 (0)					
▸	Flags: 0x4000, Don't fragment				
Fragment offset: 0					
▸	Time to live: 5				
Protocol: UDP (17)					
Header checksum: 0x6bf8 [validation disabled]					
[Header checksum status: Unverified]					