

UMinho

Mestrado em Engenharia Informática
Interligação de Redes IP (2022/2023)

GRUPO 4

TP4: ENCAMINHAMENTO DE TRÁFEGO [PROTOCOLO
BGP E OUTROS]

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1 Topologia criada

Para este trabalho prático, teremos a seguinte topologia de acordo com as restrições do enunciado:

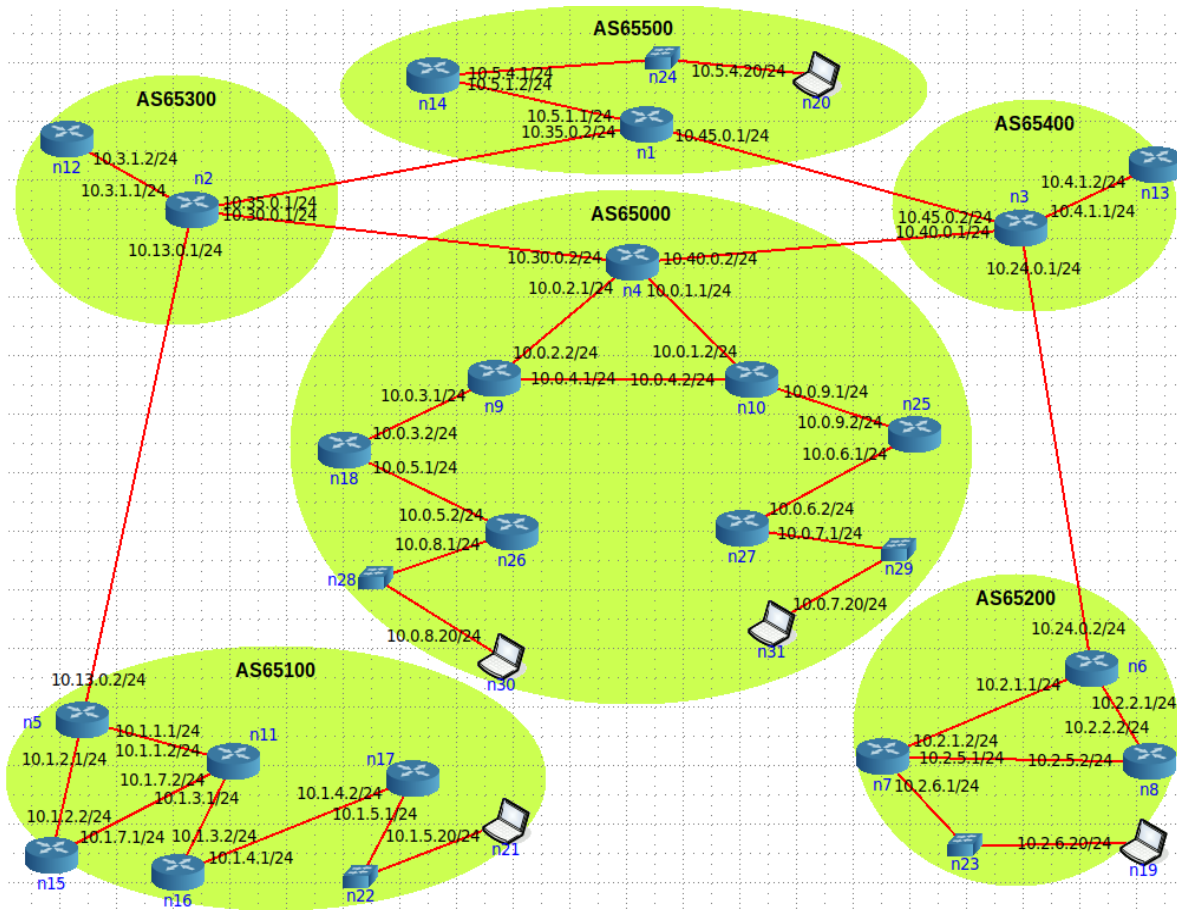


Figura 1: Topologia criada

2 Configurações

2.1 Sistema autónomo 65 000

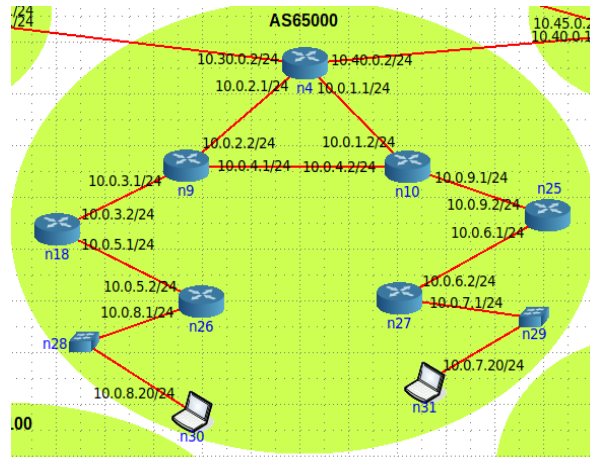


Figura 2: Sistema autónomo 65 000

2.1.1 Configurações OSPF

Foram configuradas 3 áreas OSPF diferentes dentro do sistema autónomo 6500, todos os ips contidos nestas áreas são da gama 10.0.0.0. Uma vez que todas as configurações, para as diferentes áreas, são parecidas e não sendo este o foco do TP atual vamos apenas apresentar a configuração OSPF da área 0:

```
router ospf
  router-id 10.40.0.2
  network 10.40.0.2/24 area 0
  network 10.0.1.1/24 area 0
  network 10.0.2.1/24 area 0
  network 10.30.0.2/24 area 0
```

2.1.2 Configurações BGP

Relativamente à configuração do BGP, este deve manter conetividade com os seus AS vizinhos, contudo não deve ser um sistema autónomo de transito, para tal foi removida a seguinte linha da configuração BGP de forma a desativar a propagação de rotas.

```
redistribute connected
```

Configuração BGP:

```
router bgp 65000
  bgp router-id 10.40.0.2
  network 10.0.0.0/16
  neighbor 10.40.0.1 remote-as 65400
  neighbor 10.30.0.1 remote-as 65300
```

2.2 Sistema autónomo 65 100

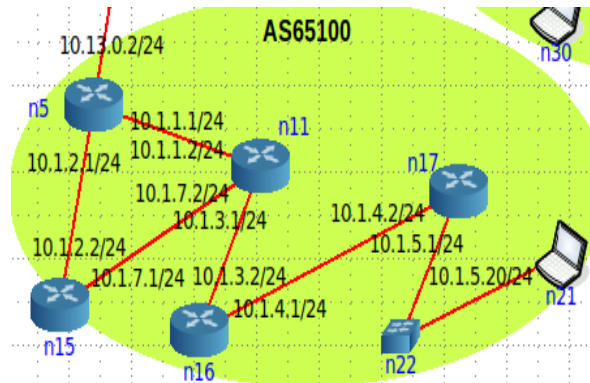


Figura 3: Sistema autónomo 65 100

2.2.1 Configurações RIP e OSPF

Uma vez que neste sistema autónomo são utilizados, internamente, 2 diferentes protocolos de encaminhamento, OSPF e RIP, é necessário que um router efetue o processo de redistribuição de rotas, no nosso caso é o router n16 da topologia através dos seguintes comandos:

```
redistribute rip
redistribute ospf
```

Configuração completa:

```
router ospf
  router-id 10.1.3.2
  network 10.1.3.2/24 area 0
  network 10.1.4.1/24 area 0
  redistribute rip
!
router rip
  redistribute static
  redistribute connected
  redistribute ospf
  network 0.0.0.0/0
!
```

Relativamente às rotas por defeito para que routers e hosts internos sejam capazes de comunicar com outros ASs utilizamos os seguintes comandos. O primeiro comando serve para redirecionar todo o tráfego por uma interface específica, e o segundo para evitar o envio de tráfego para a rede 10.2.0.0 do AS65200.

```
ip route 0.0.0.0/0 10.13.0.1
ip route 10.2.0.0/16 10.13.0.1 reject
```

2.2.2 Configurações BGP

O AS65100 deve manter conectividade com todos os outros AS com exceção do AS65200, para tal foi aplicada uma access-list que nega qualquer tráfego originado por endereços da gama 10.2.0.0.

```
router bgp 65100
  bgp router-id 10.13.0.2
  redistribute connected
  network 10.1.0.0/16
  neighbor 10.13.0.1 remote-as 65300
  neighbor 10.13.0.1 distribute-list 1 in
  access-list 1 deny 10.2.0.0 0.0.255.255
  access-list 1 permit 0.0.0.0 any
```

2.3 Sistema autónomo 65 200

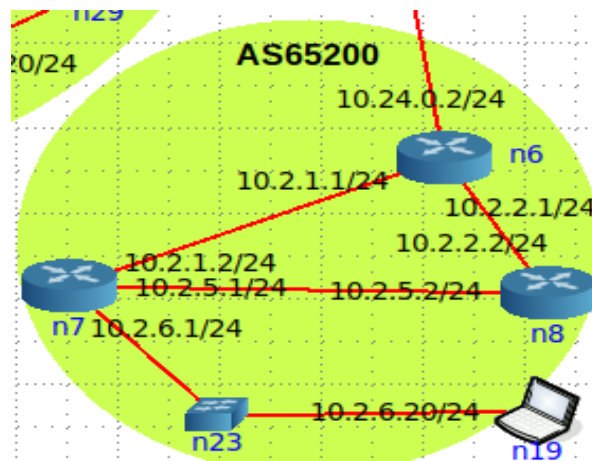


Figura 4: Sistema autónomo 65 200

2.3.1 Configurações RIP

As configurações do protocolo RIP são as mesmas já aplicadas anteriormente em outros AS e são, também, as mesmas em todos os routers do sistema autónomo 65200.

```
router rip
  redistribute static
  redistribute connected
  redistribute ospf
  network 0.0.0.0/0
```

Relativamente às rotas por defeito para que routers e hosts internos sejam capazes de comunicar com outros ASs utilizamos os seguintes comandos. O primeiro comando serve para redirecionar todo o tráfego por uma interface específica, e o segundo para evitar o envio de tráfego para a rede 10.1.0.0 do AS65100.

```
ip route 0.0.0.0/0 10.24.0.1
ip route 10.1.0.0/16 10.24.0.1 reject
```

2.3.2 Configurações BGP

As configurações relativas ao BGP são também as mesmas aplicadas previamente ao AS65100, uma vez que estes 2 sistemas autônomos (AS65100 e AS65200) não devem ter conectividade um com o outro.

```
router bgp 65200
  bgp router-id 10.24.0.2
  redistribute connected
  network 10.2.0.0/16
  neighbor 10.24.0.1 remote-as 65400
  neighbor 10.24.0.1 distribute-list 1 in
  access-list 1 deny 10.1.0.0 0.0.255.255
  access-list 1 permit 0.0.0.0 any
```

2.4 Sistemas autônomos 65 300 | 65 400 | 65 500

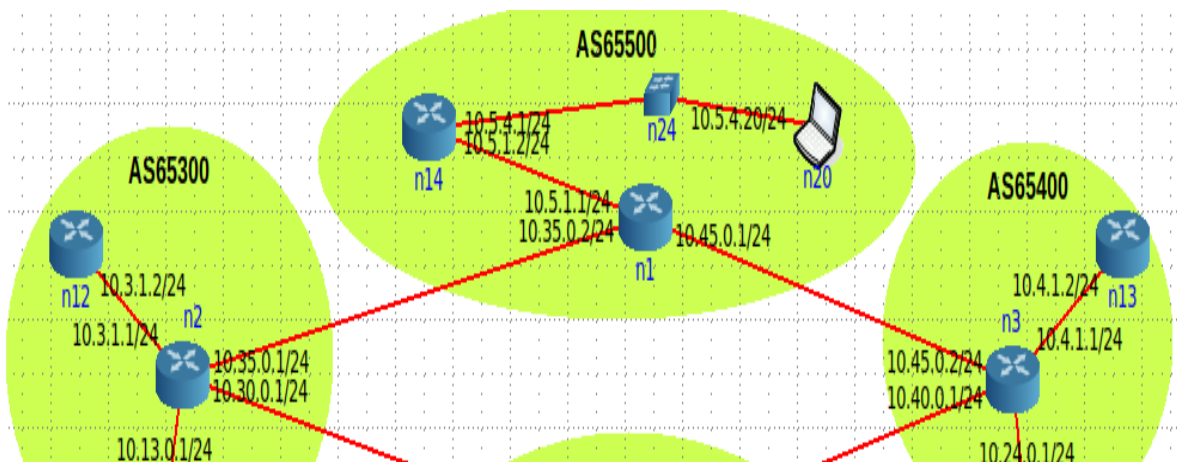


Figura 5: Sistema autônomo 65 300

2.4.1 Configurações BGP

Relativamente aos sistemas autônomos 65300, 65400 e 65500, todos eles têm uma configuração BGP parecida, vamos então apresentar a configuração do router relativo ao AS65400.

```
router bgp 65400
  bgp router-id 10.45.0.2
  redistribute connected
  network 10.4.0.0/16
  neighbor 10.45.0.1 remote-as 65500
  neighbor 10.24.0.2 remote-as 65200
  neighbor 10.40.0.2 remote-as 65000
```

3 Tabelas de encaminhamento

3.1 Tabela de encaminhamento AS 65 400

Iremos, de seguida, apresentar a tabela de encaminhamento do router relativo ao AS65400, uma vez que, é apenas este AS e no AS65300 que se pretende remover rotas que utilizem o AS6500 como sistema de transito.

```
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, o - OSPF6, I - IS-IS, B - BGP, A - Babel,
       > - selected route, * - FIB route

B>* 10.0.0.0/16 [20/0] via 10.40.0.2, eth1, 00:17:18
B>* 10.1.0.0/16 [20/0] via 10.45.0.1, eth0, 00:16:49
B>* 10.1.1.0/24 [20/0] via 10.45.0.1, eth0, 00:16:49
B>* 10.1.2.0/24 [20/0] via 10.45.0.1, eth0, 00:16:49
B>* 10.2.0.0/16 [20/0] via 10.24.0.2, eth2, 00:17:19
B>* 10.2.1.0/24 [20/1] via 10.24.0.2, eth2, 00:17:19
B>* 10.2.2.0/24 [20/1] via 10.24.0.2, eth2, 00:17:19
B>* 10.3.0.0/16 [20/0] via 10.45.0.1, eth0, 00:17:19
B>* 10.3.1.0/24 [20/0] via 10.45.0.1, eth0, 00:17:19
C>* 10.4.1.0/24 is directly connected, eth3
B>* 10.5.0.0/16 [20/0] via 10.45.0.1, eth0, 00:17:19
B>* 10.5.1.0/24 [20/1] via 10.45.0.1, eth0, 00:17:19
B>* 10.13.0.0/24 [20/0] via 10.45.0.1, eth0, 00:17:19
C>* 10.24.0.0/24 is directly connected, eth2
B>* 10.30.0.0/24 [20/0] via 10.45.0.1, eth0, 00:17:19
B>* 10.35.0.0/24 [20/1] via 10.45.0.1, eth0, 00:17:19
C>* 10.40.0.0/24 is directly connected, eth1
C>* 10.45.0.0/24 is directly connected, eth0
C>* 127.0.0.0/8 is directly connected, lo
n3#
```

Figura 6: Routing Table AS 65 400

Como podemos observar na figura em cima, o AS65400 não utiliza o AS6500 como sistema de transito (Interface 10.40.0.2).

3.2 Tabela de encaminhamento AS 65 200 e AS 65 100

Vamos agora apresentar as tabelas de encaminhamento dos routers BGP relativos aos sistemas autónomos AS65100 e AS65200.

```
> - selected route, * - FIB route

S>* 0.0.0.0/0 [1/0] via 10.13.0.1, eth0
B>* 10.0.0.0/16 [20/0] via 10.13.0.1, eth0, 00:01:43
O 10.1.1.0/24 [110/10] is directly connected, eth1, 00:02:17
C>* 10.1.1.0/24 is directly connected, eth1
O 10.1.2.0/24 [110/30] via 10.1.1.2, eth1, 00:02:04
C>* 10.1.2.0/24 is directly connected, eth2
O>* 10.1.3.0/24 [110/20] via 10.1.1.2, eth1, 00:02:14
O>* 10.1.4.0/24 [110/30] via 10.1.1.2, eth1, 00:02:04
O>* 10.1.5.0/24 [110/20] via 10.1.1.2, eth1, 00:02:03
O>* 10.1.7.0/24 [110/20] via 10.1.1.2, eth1, 00:02:14
S>* 10.2.0.0/16 [1/0] via 10.13.0.1, eth0, rej
B>* 10.3.0.0/16 [20/0] via 10.13.0.1, eth0, 00:02:13
B>* 10.3.1.0/24 [20/1] via 10.13.0.1, eth0, 00:02:13
B>* 10.4.0.0/16 [20/0] via 10.13.0.1, eth0, 00:01:43
B>* 10.4.1.0/24 [20/0] via 10.13.0.1, eth0, 00:01:43
B>* 10.5.0.0/16 [20/0] via 10.13.0.1, eth0, 00:01:43
B>* 10.5.1.0/24 [20/0] via 10.13.0.1, eth0, 00:01:43
O 10.13.0.0/24 [110/10] is directly connected, eth0, 00:02:17
C>* 10.13.0.0/24 is directly connected, eth0
B>* 10.24.0.0/24 [20/0] via 10.13.0.1, eth0, 00:01:43
B>* 10.30.0.0/24 [20/1] via 10.13.0.1, eth0, 00:02:13
B>* 10.35.0.0/24 [20/1] via 10.13.0.1, eth0, 00:02:13
B>* 10.40.0.0/24 [20/0] via 10.13.0.1, eth0, 00:01:43
B>* 10.45.0.0/24 [20/0] via 10.13.0.1, eth0, 00:01:43
C>* 127.0.0.0/8 is directly connected, lo
n5#
```

Figura 7: Routing Table AS 65 100

Podemos observar que a rota dirigida ao AS65200 é rejeitada ("rej").


```

n6# show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, o - OSPF6, I - IS-IS, B - BGP, A - Babel,
       > - selected route, * - FIB route

S>* 0.0.0.0/0 [1/0] via 10.24.0.1, eth0
B>* 10.0.0.0/16 [20/0] via 10.24.0.1, eth0, 00:02:49
S>* 10.1.0.0/16 [1/0] via 10.24.0.1, eth0, rej
C>* 10.2.1.0/24 is directly connected, eth1
C>* 10.2.2.0/24 is directly connected, eth2
R>* 10.2.5.0/24 [120/2] via 10.2.2.2, eth2, 00:02:51
R>* 10.2.6.0/24 [120/2] via 10.2.1.2, eth1, 00:02:51
B>* 10.3.0.0/16 [20/0] via 10.24.0.1, eth0, 00:02:19
B>* 10.3.1.0/24 [20/0] via 10.24.0.1, eth0, 00:02:19
B>* 10.4.0.0/16 [20/0] via 10.24.0.1, eth0, 00:02:49
B>* 10.4.1.0/24 [20/1] via 10.24.0.1, eth0, 00:02:49
B>* 10.5.0.0/16 [20/0] via 10.24.0.1, eth0, 00:02:49
B>* 10.5.1.0/24 [20/0] via 10.24.0.1, eth0, 00:02:49
R>* 10.13.0.0/24 [20/0] via 10.24.0.1, eth0, 00:02:19
C>* 10.24.0.0/24 is directly connected, eth0
B>* 10.30.0.0/24 [20/0] via 10.24.0.1, eth0, 00:02:19
B>* 10.35.0.0/24 [20/0] via 10.24.0.1, eth0, 00:02:49
B>* 10.40.0.0/24 [20/1] via 10.24.0.1, eth0, 00:02:49
B>* 10.45.0.0/24 [20/1] via 10.24.0.1, eth0, 00:02:49
C>* 127.0.0.0/8 is directly connected, lo
n6#

```

Figura 8: Routing Table AS 65 200

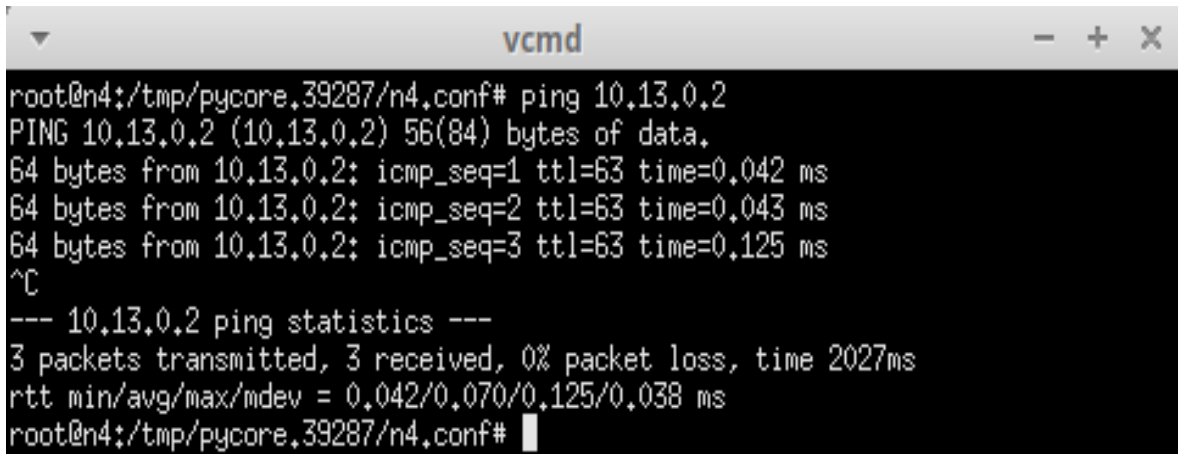
O mesmo acontece na tabela relativa ao AS65200, onde a rota dirigida ao AS65100 é também rejeitada ("rej").

4 Testes de conectividade

Nesta secção iremos efetuar testes de conectividade de cada sistema autónomo para os outros sistemas, provando a existência de conectividade (ou não), consoante o pedido no enunciado.

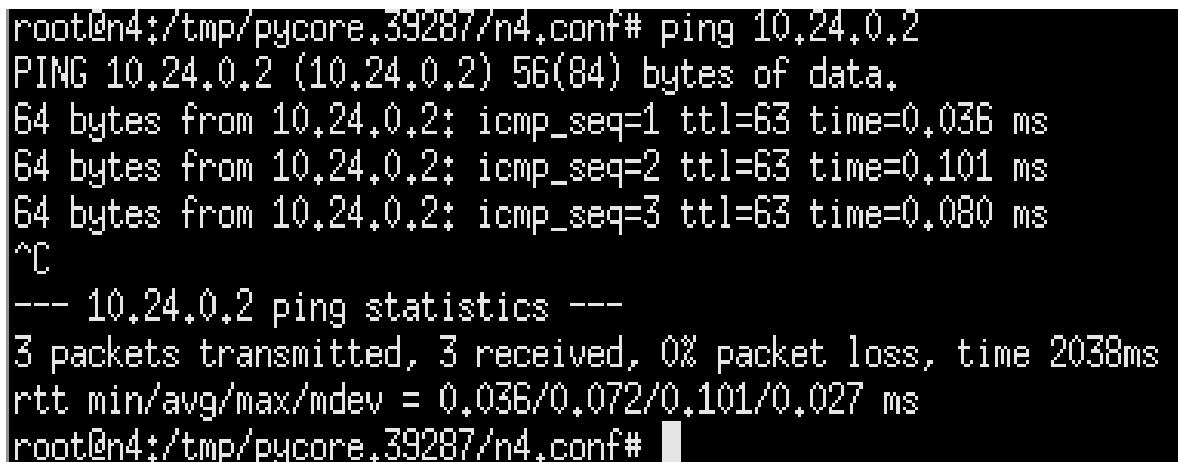
4.1 Sistema autónomo 65 000

Tal como podemos observar abaixo, existe conectividade de AS65000 para os outros AS.



```
root@n4:/tmp/pycore.39287/n4.conf# ping 10.13.0.2
PING 10.13.0.2 (10.13.0.2) 56(84) bytes of data.
64 bytes from 10.13.0.2: icmp_seq=1 ttl=63 time=0.042 ms
64 bytes from 10.13.0.2: icmp_seq=2 ttl=63 time=0.043 ms
64 bytes from 10.13.0.2: icmp_seq=3 ttl=63 time=0.125 ms
^C
--- 10.13.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.042/0.070/0.125/0.038 ms
root@n4:/tmp/pycore.39287/n4.conf#
```

Figura 9: Ping AS65000 → AS65100



```
root@n4:/tmp/pycore.39287/n4.conf# ping 10.24.0.2
PING 10.24.0.2 (10.24.0.2) 56(84) bytes of data.
64 bytes from 10.24.0.2: icmp_seq=1 ttl=63 time=0.036 ms
64 bytes from 10.24.0.2: icmp_seq=2 ttl=63 time=0.101 ms
64 bytes from 10.24.0.2: icmp_seq=3 ttl=63 time=0.080 ms
^C
--- 10.24.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2038ms
rtt min/avg/max/mdev = 0.036/0.072/0.101/0.027 ms
root@n4:/tmp/pycore.39287/n4.conf#
```

Figura 10: Ping AS65000 → AS65200

```

root@n4:/tmp/pycore.39287/n4.conf# ping 10.30.0.1
PING 10.30.0.1 (10.30.0.1) 56(84) bytes of data.
64 bytes from 10.30.0.1: icmp_seq=1 ttl=64 time=0.115 ms
64 bytes from 10.30.0.1: icmp_seq=2 ttl=64 time=0.071 ms
64 bytes from 10.30.0.1: icmp_seq=3 ttl=64 time=0.037 ms
^C
--- 10.30.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2034ms
rtt min/avg/max/mdev = 0.037/0.074/0.115/0.031 ms
root@n4:/tmp/pycore.39287/n4.conf# █

```

Figura 11: Ping AS65000 → AS65300

```

root@n4:/tmp/pycore.39287/n4.conf# ping 10.40.0.1
PING 10.40.0.1 (10.40.0.1) 56(84) bytes of data.
64 bytes from 10.40.0.1: icmp_seq=1 ttl=64 time=0.074 ms
64 bytes from 10.40.0.1: icmp_seq=2 ttl=64 time=0.037 ms
64 bytes from 10.40.0.1: icmp_seq=3 ttl=64 time=0.042 ms
^C
--- 10.40.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2045ms
rtt min/avg/max/mdev = 0.037/0.051/0.074/0.016 ms
root@n4:/tmp/pycore.39287/n4.conf# █

```

Figura 12: Ping AS65000 → AS65400

```

root@n4:/tmp/pycore.39287/n4.conf# ping 10.35.0.2
PING 10.35.0.2 (10.35.0.2) 56(84) bytes of data.
64 bytes from 10.35.0.2: icmp_seq=1 ttl=63 time=0.066 ms
64 bytes from 10.35.0.2: icmp_seq=2 ttl=63 time=0.049 ms
64 bytes from 10.35.0.2: icmp_seq=3 ttl=63 time=0.058 ms
64 bytes from 10.35.0.2: icmp_seq=4 ttl=63 time=0.048 ms
^C
--- 10.35.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3056ms
rtt min/avg/max/mdev = 0.048/0.055/0.066/0.007 ms

```

Figura 13: Ping AS65000 → AS65500

4.2 Sistema autónomo 65 100

Tal como podemos observar nas figuras abaixo, existe conectividade deste AS para todos os outros, exceto para AS65200.

```
root@n5:/tmp/pycore.39287/n5.conf# ping 10.30.0.2
PING 10.30.0.2 (10.30.0.2) 56(84) bytes of data.
64 bytes from 10.30.0.2: icmp_seq=1 ttl=63 time=0.097 ms
64 bytes from 10.30.0.2: icmp_seq=2 ttl=63 time=0.087 ms
64 bytes from 10.30.0.2: icmp_seq=3 ttl=63 time=0.047 ms
^C
--- 10.30.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2041ms
rtt min/avg/max/mdev = 0.047/0.077/0.097/0.021 ms
root@n5:/tmp/pycore.39287/n5.conf#
```

Figura 14: Ping AS65100 → AS65000

```
root@n5:/tmp/pycore.42499/n5.conf# ping 10.24.0.2
PING 10.24.0.2 (10.24.0.2) 56(84) bytes of data.
From 10.13.0.1 icmp_seq=1 Destination Net Unreachable
From 10.13.0.1 icmp_seq=2 Destination Net Unreachable
From 10.13.0.1 icmp_seq=3 Destination Net Unreachable
From 10.13.0.1 icmp_seq=4 Destination Net Unreachable
^C
--- 10.24.0.2 ping statistics ---
6 packets transmitted, 0 received, +4 errors, 100% packet loss, time 5122ms
root@n5:/tmp/pycore.42499/n5.conf#
```

Figura 15: Ping AS65100 → AS65200

```

root@n5:/tmp/pycore.39287/n5.conf# ping 10.13.0.1
PING 10.13.0.1 (10.13.0.1) 56(84) bytes of data.
64 bytes from 10.13.0.1: icmp_seq=1 ttl=64 time=0.033 ms
64 bytes from 10.13.0.1: icmp_seq=2 ttl=64 time=0.061 ms
64 bytes from 10.13.0.1: icmp_seq=3 ttl=64 time=0.049 ms
^C
--- 10.13.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2045ms
rtt min/avg/max/mdev = 0.033/0.047/0.061/0.011 ms
root@n5:/tmp/pycore.39287/n5.conf# █

```

Figura 16: Ping AS65100 → AS65300

```

root@n5:/tmp/pycore.39287/n5.conf# ping 10.40.0.1
PING 10.40.0.1 (10.40.0.1) 56(84) bytes of data.
64 bytes from 10.40.0.1: icmp_seq=1 ttl=62 time=0.047 ms
64 bytes from 10.40.0.1: icmp_seq=2 ttl=62 time=0.058 ms
64 bytes from 10.40.0.1: icmp_seq=3 ttl=62 time=0.051 ms
^C
--- 10.40.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2044ms
rtt min/avg/max/mdev = 0.047/0.052/0.058/0.004 ms
root@n5:/tmp/pycore.39287/n5.conf# █

```

Figura 17: Ping AS65100 → AS65400

```

root@n5:/tmp/pycore.39287/n5.conf# ping 10.35.0.2
PING 10.35.0.2 (10.35.0.2) 56(84) bytes of data.
64 bytes from 10.35.0.2: icmp_seq=1 ttl=63 time=0.042 ms
64 bytes from 10.35.0.2: icmp_seq=2 ttl=63 time=0.176 ms
64 bytes from 10.35.0.2: icmp_seq=3 ttl=63 time=0.075 ms
^C
--- 10.35.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2061ms
rtt min/avg/max/mdev = 0.042/0.097/0.176/0.057 ms
root@n5:/tmp/pycore.39287/n5.conf# █

```

Figura 18: Ping AS65100 → AS65500

4.3 Sistema autónomo 65 200

Tal como podemos observar nas figuras abaixo, existe conectividade deste AS para todos os outros, exceto para AS65100.

```
root@n6:/tmp/pycore.39287/n6.conf# ping 10.40.0.2
PING 10.40.0.2 (10.40.0.2) 56(84) bytes of data.
64 bytes from 10.40.0.2: icmp_seq=1 ttl=63 time=0.038 ms
64 bytes from 10.40.0.2: icmp_seq=2 ttl=63 time=0.047 ms
64 bytes from 10.40.0.2: icmp_seq=3 ttl=63 time=0.050 ms
^C
--- 10.40.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2036ms
rtt min/avg/max/mdev = 0.038/0.045/0.050/0.005 ms
root@n6:/tmp/pycore.39287/n6.conf#
```

Figura 19: Ping AS65200 → AS65000

```
root@n6:/tmp/pycore.42499/n6.conf# ping 10.13.0.2
PING 10.13.0.2 (10.13.0.2) 56(84) bytes of data.
From 10.24.0.1 icmp_seq=1 Destination Net Unreachable
From 10.24.0.1 icmp_seq=2 Destination Net Unreachable
From 10.24.0.1 icmp_seq=3 Destination Net Unreachable
From 10.24.0.1 icmp_seq=4 Destination Net Unreachable
^C
--- 10.13.0.2 ping statistics ---
5 packets transmitted, 0 received, +4 errors, 100% packet loss, time 4100ms
root@n6:/tmp/pycore.42499/n6.conf#
```

Figura 20: Ping AS65200 → AS65100

```

root@n6:/tmp/pycore.39287/n6.conf# ping 10.30.0.1
PING 10.30.0.1 (10.30.0.1) 56(84) bytes of data.
64 bytes from 10.30.0.1: icmp_seq=1 ttl=62 time=0.082 ms
64 bytes from 10.30.0.1: icmp_seq=2 ttl=62 time=0.061 ms
64 bytes from 10.30.0.1: icmp_seq=3 ttl=62 time=0.105 ms
^C
--- 10.30.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2056ms
rtt min/avg/max/mdev = 0.061/0.082/0.105/0.017 ms
root@n6:/tmp/pycore.39287/n6.conf# █

```

Figura 21: Ping AS65200 → AS65300

```

root@n6:/tmp/pycore.39287/n6.conf# ping 10.24.0.1
PING 10.24.0.1 (10.24.0.1) 56(84) bytes of data.
64 bytes from 10.24.0.1: icmp_seq=1 ttl=64 time=0.030 ms
64 bytes from 10.24.0.1: icmp_seq=2 ttl=64 time=0.076 ms
64 bytes from 10.24.0.1: icmp_seq=3 ttl=64 time=0.042 ms
^C
--- 10.24.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2035ms
rtt min/avg/max/mdev = 0.030/0.049/0.076/0.019 ms
root@n6:/tmp/pycore.39287/n6.conf# █

```

Figura 22: Ping AS65200 → AS65400

```

root@n6:/tmp/pycore.39287/n6.conf# ping 10.45.0.1
PING 10.45.0.1 (10.45.0.1) 56(84) bytes of data.
64 bytes from 10.45.0.1: icmp_seq=1 ttl=63 time=0.037 ms
64 bytes from 10.45.0.1: icmp_seq=2 ttl=63 time=0.047 ms
64 bytes from 10.45.0.1: icmp_seq=3 ttl=63 time=0.048 ms
^C
--- 10.45.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2029ms
rtt min/avg/max/mdev = 0.037/0.044/0.048/0.005 ms
root@n6:/tmp/pycore.39287/n6.conf# █

```

Figura 23: Ping AS65200 → AS65500

4.4 Sistema autónomo 65 300

Tal como podemos observar abaixo, existe conectividade de AS65300 para os outros AS.

```
root@n2:/tmp/pycore.39287/n2.conf# ping 10.13.0.2
PING 10.13.0.2 (10.13.0.2) 56(84) bytes of data.
64 bytes from 10.13.0.2: icmp_seq=1 ttl=64 time=0.029 ms
64 bytes from 10.13.0.2: icmp_seq=2 ttl=64 time=0.038 ms
64 bytes from 10.13.0.2: icmp_seq=3 ttl=64 time=0.038 ms
^C
--- 10.13.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2049ms
rtt min/avg/max/mdev = 0.029/0.035/0.038/0.004 ms
root@n2:/tmp/pycore.39287/n2.conf#
```

Figura 24: Ping AS65300 → AS65000

```
root@n2:/tmp/pycore.39287/n2.conf# ping 10.13.0.2
PING 10.13.0.2 (10.13.0.2) 56(84) bytes of data.
64 bytes from 10.13.0.2: icmp_seq=1 ttl=64 time=0.029 ms
64 bytes from 10.13.0.2: icmp_seq=2 ttl=64 time=0.038 ms
64 bytes from 10.13.0.2: icmp_seq=3 ttl=64 time=0.038 ms
^C
--- 10.13.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2049ms
rtt min/avg/max/mdev = 0.029/0.035/0.038/0.004 ms
root@n2:/tmp/pycore.39287/n2.conf#
```

Figura 25: Ping AS65300 → AS65100


```

root@n2:/tmp/pycore.39287/n2.conf# ping 10.24.0.2
PING 10.24.0.2 (10.24.0.2) 56(84) bytes of data.
64 bytes from 10.24.0.2: icmp_seq=1 ttl=62 time=0.048 ms
64 bytes from 10.24.0.2: icmp_seq=2 ttl=62 time=0.042 ms
64 bytes from 10.24.0.2: icmp_seq=3 ttl=62 time=0.056 ms
^C
--- 10.24.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2044ms
rtt min/avg/max/mdev = 0.042/0.048/0.056/0.005 ms
root@n2:/tmp/pycore.39287/n2.conf# █

```

Figura 26: Ping AS65300 → AS65200

```

root@n2:/tmp/pycore.39287/n2.conf# ping 10.40.0.1
PING 10.40.0.1 (10.40.0.1) 56(84) bytes of data.
64 bytes from 10.40.0.1: icmp_seq=1 ttl=63 time=0.036 ms
64 bytes from 10.40.0.1: icmp_seq=2 ttl=63 time=0.048 ms
64 bytes from 10.40.0.1: icmp_seq=3 ttl=63 time=0.046 ms
^C
--- 10.40.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2038ms
rtt min/avg/max/mdev = 0.036/0.043/0.048/0.005 ms
root@n2:/tmp/pycore.39287/n2.conf# █

```

Figura 27: Ping AS65300 → AS65400

```

root@n2:/tmp/pycore.39287/n2.conf# ping 10.35.0.2
PING 10.35.0.2 (10.35.0.2) 56(84) bytes of data.
64 bytes from 10.35.0.2: icmp_seq=1 ttl=64 time=0.029 ms
64 bytes from 10.35.0.2: icmp_seq=2 ttl=64 time=0.037 ms
64 bytes from 10.35.0.2: icmp_seq=3 ttl=64 time=0.043 ms
^C
--- 10.35.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2027ms
rtt min/avg/max/mdev = 0.029/0.036/0.043/0.005 ms
root@n2:/tmp/pycore.39287/n2.conf# █

```

Figura 28: Ping AS65300 → AS65500

4.5 Sistema autónomo 65 400

Tal como podemos observar abaixo, existe conectividade de AS65400 para os outros AS.

```
root@n3:/tmp/pycore.39287/n3.conf# ping 10.40.0.2
PING 10.40.0.2 (10.40.0.2) 56(84) bytes of data.
64 bytes from 10.40.0.2: icmp_seq=1 ttl=64 time=0.047 ms
64 bytes from 10.40.0.2: icmp_seq=2 ttl=64 time=0.099 ms
64 bytes from 10.40.0.2: icmp_seq=3 ttl=64 time=0.105 ms
^C
--- 10.40.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2043ms
rtt min/avg/max/mdev = 0.047/0.083/0.105/0.026 ms
root@n3:/tmp/pycore.39287/n3.conf#
```

Figura 29: Ping AS65400 → AS60000

```
root@n3:/tmp/pycore.39287/n3.conf# ping 10.13.0.2
PING 10.13.0.2 (10.13.0.2) 56(84) bytes of data.
64 bytes from 10.13.0.2: icmp_seq=1 ttl=62 time=0.137 ms
64 bytes from 10.13.0.2: icmp_seq=2 ttl=62 time=0.070 ms
64 bytes from 10.13.0.2: icmp_seq=3 ttl=62 time=0.061 ms
64 bytes from 10.13.0.2: icmp_seq=4 ttl=62 time=0.050 ms
^C64 bytes from 10.13.0.2: icmp_seq=5 ttl=62 time=0.052 ms
64 bytes from 10.13.0.2: icmp_seq=6 ttl=62 time=0.054 ms
^C
--- 10.13.0.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5085ms
rtt min/avg/max/mdev = 0.050/0.070/0.137/0.030 ms
root@n3:/tmp/pycore.39287/n3.conf#
```

Figura 30: Ping AS65400 → AS65100

```

root@n3:/tmp/pycore.39287/n3.conf# ping 10.24.0.2
PING 10.24.0.2 (10.24.0.2) 56(84) bytes of data.
64 bytes from 10.24.0.2: icmp_seq=1 ttl=64 time=0.048 ms
64 bytes from 10.24.0.2: icmp_seq=2 ttl=64 time=0.031 ms
64 bytes from 10.24.0.2: icmp_seq=3 ttl=64 time=0.039 ms
^C
--- 10.24.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2052ms
rtt min/avg/max/mdev = 0.031/0.039/0.048/0.007 ms
root@n3:/tmp/pycore.39287/n3.conf# █

```

Figura 31: Ping AS65400 → AS65200

```

root@n3:/tmp/pycore.39287/n3.conf# ping 10.35.0.1
PING 10.35.0.1 (10.35.0.1) 56(84) bytes of data.
64 bytes from 10.35.0.1: icmp_seq=1 ttl=63 time=0.058 ms
64 bytes from 10.35.0.1: icmp_seq=2 ttl=63 time=0.046 ms
64 bytes from 10.35.0.1: icmp_seq=3 ttl=63 time=0.114 ms
^C
--- 10.35.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2033ms
rtt min/avg/max/mdev = 0.046/0.072/0.114/0.029 ms
root@n3:/tmp/pycore.39287/n3.conf# █

```

Figura 32: Ping AS65400 → AS65300

```

root@n3:/tmp/pycore.39287/n3.conf# ping 10.45.0.1
PING 10.45.0.1 (10.45.0.1) 56(84) bytes of data.
64 bytes from 10.45.0.1: icmp_seq=1 ttl=64 time=0.116 ms
64 bytes from 10.45.0.1: icmp_seq=2 ttl=64 time=0.040 ms
64 bytes from 10.45.0.1: icmp_seq=3 ttl=64 time=0.040 ms
^C
--- 10.45.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2029ms
rtt min/avg/max/mdev = 0.040/0.065/0.116/0.035 ms
root@n3:/tmp/pycore.39287/n3.conf# █

```

Figura 33: Ping AS65400 → AS65500

4.6 Sistema autónomo 65 500

Tal como podemos observar abaixo, existe conectividade de AS65500 para os outros AS.

```
root@n1:/tmp/pycore.39287/n1.conf# ping 10.30.0.2
PING 10.30.0.2 (10.30.0.2) 56(84) bytes of data.
64 bytes from 10.30.0.2: icmp_seq=1 ttl=63 time=0.094 ms
64 bytes from 10.30.0.2: icmp_seq=2 ttl=63 time=0.058 ms
64 bytes from 10.30.0.2: icmp_seq=3 ttl=63 time=0.073 ms
^C
--- 10.30.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2025ms
rtt min/avg/max/mdev = 0.058/0.075/0.094/0.014 ms
root@n1:/tmp/pycore.39287/n1.conf#
```

Figura 34: Ping AS65500 → AS65000

```
root@n1:/tmp/pycore.39287/n1.conf# ping 10.13.0.2
PING 10.13.0.2 (10.13.0.2) 56(84) bytes of data.
64 bytes from 10.13.0.2: icmp_seq=1 ttl=63 time=0.135 ms
64 bytes from 10.13.0.2: icmp_seq=2 ttl=63 time=0.076 ms
64 bytes from 10.13.0.2: icmp_seq=3 ttl=63 time=0.048 ms
^C
--- 10.13.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2036ms
rtt min/avg/max/mdev = 0.048/0.086/0.135/0.036 ms
root@n1:/tmp/pycore.39287/n1.conf#
```

Figura 35: Ping AS65500 → AS65100

```

root@n1:/tmp/pycore.39287/n1.conf# ping 10.24.0.2
PING 10.24.0.2 (10.24.0.2) 56(84) bytes of data.
64 bytes from 10.24.0.2: icmp_seq=1 ttl=63 time=0.111 ms
64 bytes from 10.24.0.2: icmp_seq=2 ttl=63 time=0.100 ms
64 bytes from 10.24.0.2: icmp_seq=3 ttl=63 time=0.141 ms
^C
--- 10.24.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2054ms
rtt min/avg/max/mdev = 0.100/0.117/0.141/0.017 ms
root@n1:/tmp/pycore.39287/n1.conf# █

```

Figura 36: Ping AS65500 → AS65200

```

root@n1:/tmp/pycore.39287/n1.conf# ping 10.35.0.1
PING 10.35.0.1 (10.35.0.1) 56(84) bytes of data.
64 bytes from 10.35.0.1: icmp_seq=1 ttl=64 time=0.088 ms
64 bytes from 10.35.0.1: icmp_seq=2 ttl=64 time=0.066 ms
64 bytes from 10.35.0.1: icmp_seq=3 ttl=64 time=0.037 ms
^C
--- 10.35.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2042ms
rtt min/avg/max/mdev = 0.037/0.063/0.088/0.020 ms
root@n1:/tmp/pycore.39287/n1.conf# █

```

Figura 37: Ping AS65500 → AS65300

```

root@n1:/tmp/pycore.39287/n1.conf# ping 10.45.0.2
PING 10.45.0.2 (10.45.0.2) 56(84) bytes of data.
64 bytes from 10.45.0.2: icmp_seq=1 ttl=64 time=0.073 ms
64 bytes from 10.45.0.2: icmp_seq=2 ttl=64 time=0.056 ms
64 bytes from 10.45.0.2: icmp_seq=3 ttl=64 time=0.048 ms
^C
--- 10.45.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2037ms
rtt min/avg/max/mdev = 0.048/0.059/0.073/0.010 ms
root@n1:/tmp/pycore.39287/n1.conf# █

```

Figura 38: Ping AS65500 → AS65400