

# Tópicos Avançados De Redes

PROJETO GNS3

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## Topologia de Rede

### ○ AS #6000

R1(Lo)	2222:2397:1::1/128	12.0.0.1/32
R2(Lo)	2222:2397:1::2/128	12.0.0.2/32
R3(Lo)	2222:2397:1::3/128	12.0.0.3/32
R4(Lo)	2222:2397:1::4/128	12.0.0.4/32
R1(fo/o) ->R2(fo/o)	2222:2397:1:1::/64	12.0.1.0/30
R2(fo/i) ->R3(fo/i)	2222:2397:1:2::/64	12.0.1.4/30
R2(fi/o) ->R4(fi/o)	2222:2397:1:3::/64	12.0.1.8/30
R1(fo/i) ->R4(fo/o)	2222:2397:1:4::/64	12.0.1.12/30
R1(g3/o) ->A2-R1(g3/o)	2222:2397:1:5::/64	12.0.1.17/30
R1(g4/o) ->A2-R1(g4/o)	2222:2397:1:6::/64	12.0.1.21/30
R3(g3/o) ->B1-R1(g3/o)	2222:2397:1:7::/64	12.0.1.25/30
R3(g4/o) 3->B1-R1(g4/o)	2222:2397:1:8::/64	12.0.1.29/30
R4(g3/o) ->B1-R2(g3/o)	2222:2397:1:9::/64	12.0.1.33/30
R4(g4/o) ->B1-R2(g4/o)	2222:2397:1:A::/64	12.0.1.37/30
R4(g5/o) ->B2-R2(g5/o)	2222:2397:1:B::/64	12.0.1.41/30
Link-Local	FE80::6000:x	

### ○ AS #6001

R1(Lo)	2222:2397:2::1/128	13.0.0.1/32
R2(Lo)	2222:2397:2::2/128	13.0.0.2/32
R3(Lo)	2222:2397:2::3/128	13.0.0.3/32
R4(Lo)	2222:2397:2::4/128	13.0.0.4/32
R1(fo/i) ->R3(fo/i)	2222:2397:2:1::/64	13.0.1.0/30
R2(fi/o) ->R3 (i/o)	2222:2397:2:2::/64	13.0.1.4/30
R3(fo/o) ->R4(fo/o)	2222:2397:2:3::/64	13.0.1.8/30
R2(fo/o) ->R4(fo/i)	2222:2397:2:4::/64	13.0.1.12/30
B1-R1(g3/o) ->A1-R3(g3/o)	2222:2397:1:7::2/64	12.0.1.26/30
B1-R1(g4/o) ->A1-R3(g4/o)	2222:2397:1:8::2/64	12.0.1.30/30
B1-R4(g3/o) ->B2-R1(g3/o)	2222:2397:2:5::1/64	13.0.1.17/30
B1-R4(g4/o) ->B2-R1(g4/o)	2222:2397:2:6::1/64	13.0.1.21/30
B1-R2(g5/o) ->A2-R3(g5/o)	2222:2397:2:7::1/64	13.0.1.25/30
B1-R2(g3/o) ->A1-R4(g3/o)	2222:2397:1:9::2/64	12.0.1.34/30
B1-R2(g4/o) ->A1-R4(g4/o)	2222:2397:1:A::2/64	12.0.1.38/30
Link-Local	FE80::6001:x	

○ AS #9001

R1(Lo)	2222:2397:3::1/128	14.0.0.1/32
R2(Lo)	2222:2397:3::2/128	14.0.0.2/32
R3(Lo)	2222:2397:3::3/128	14.0.0.3/32
R4(Lo)	2222:2397:3::4/128	14.0.0.4/32
R1(fo/1) ->R2(fo/1)	2222:2397:3:1::/64	14.0.1.0/30
R1(fi/o) ->R3(fo/1)	2222:2397:3:2::/64	14.0.1.4/30
R1(fo/o) ->R4(fo/o)	2222:2397:3:3::/64	14.0.1.8/30
R2(fo/o) ->R3(fo/o)	2222:2397:3:4::/64	14.0.1.12/30
R2(fi/o) ->R4(fi/o)	2222:2397:3:5::/64	14.0.1.16/30
R4(g3/o) ->A3-R1(g3/o)	2222:2397:3:6::1/64	14.0.1.21/30
R3(g4/o) ->A3-R1(g4/o)	2222:2397:3:7::1/64	14.0.1.25/30
R3(g3/o) ->A3-R3(g5/o)	2222:2397:3:8::1/64	14.0.1.29/30
A2-R3(g5/o)->B1-R2(g5/o)	2222:2397:2:7::2/64	13.0.1.26/30
A2-R1(g3/o) ->A1-R1(g3/o)	2222:2397:1:5::2/64	12.0.1.18/30
A2-R1(g4/o) ->A1-R1(g4/o)	2222:2397:1:6::2/64	12.0.1.22/30
Link-Local	FE80::9001:x	

○ AS #9002

R1(Lo)	2222:2397:4::1/128	15.0.0.1/32
R2(Lo)	2222:2397:4::2/128	15.0.0.2/32
R3(Lo)	2222:2397:4::3/128	15.0.0.3/32
R1(fo/o) ->R2(fo/o)	2222:2397:4:1::/64	15.0.1.0/30
R1(fo/1) ->R3(fo/1)	2222:2397:4:2::/64	15.0.1.4/30
R2(fi/o) ->R3(fi/o)	2222:2397:4:3::/64	15.0.1.8/30
R2(g6/o) ->A3-R1(g5/o)	2222:2397:4:4::1/64	15.0.1.13/30
R2(g3/o) ->A3-R3(g3/o)	2222:2397:4:5::1/64	15.0.1.17/30
R2(g4/o) ->A3-R3(g4/o)	2222:2397:4:6::1/64	15.0.1.21/30
B2-R2(g5/o) ->A1-R4(g5/o)	2222:2397:1:B::2/64	12.0.1.42/30
B2-R1(g3/o) ->B1-R4(g3/o)	2222:2397:2:5::2/64	13.0.1.18/30
B2-R1(g4/o) ->B1-R4(g4/o)	2222:2397:2:6::2/64	13.0.1.22/30
B2-R2(fo/o) ->ServerAS9002	2222:2397:4:7::1/64	15.0.2.1/24
ServerAS9002	2222:2397:4:7::2/64	15.0.2.2/24
Link-Local	FE80::9002:x	

○ AS #10001

R1(Lo)	2222:2397:5::1/128	16.0.0.1/32
R2(Lo)	2222:2397:5::2/128	16.0.0.2/32
R3(Lo)	2222:2397:5::3/128	16.0.0.3/32
R4(Lo)	2222:2397:5::4/128	16.0.0.4/32
R5(Lo)	2222:2397:5::5/128	16.0.0.5/32
R6(Lo)	2222:2397:5::6/128	16.0.0.6/32
R7(Lo)	2222:2397:5::7/128	16.0.0.7/32
R8(Lo)	2222:2397:5::8/128	16.0.0.8/32
R9(Lo)	2222:2397:5::9/128	16.0.0.9/32
R10(Lo)	2222:2397:5::A/128	16.0.0.10/32
R11(Lo)	2222:2397:5::B/128	16.0.0.11/32
R12(Lo)	2222:2397:5::C/128	16.0.0.12/32
R1(fo/o) ->R2(fo/i)	2222:2397:5:1::/64	16.0.1.0/30
R2(fo/i) ->R4(fo/o)	2222:2397:5:2::/64	16.0.1.4/30
R3(fo/o) ->R4(fo/i)	2222:2397:5:3::/64	16.0.1.8/30
R4(2/o) ->R5(fo/i)	2222:2397:5:4::/64	16.0.1.12/30
R5(fo/o) ->R6(fo/o)	2222:2397:5:5::/64	16.0.1.16/30
R4(fi/i) ->R7(fo/i)	2222:2397:5:6::/64	16.0.1.20/30
R7(fo/o) ->R8(fo/o)	2222:2397:5:7::/64	16.0.1.24/30
R8(fo/i) ->R9(fo/i)	2222:2397:5:8::/64	16.0.1.28/30
R9(fo/o) ->R10(fo/o)	2222:2397:5:9::/64	16.0.1.32/30
R4(fi/o) ->R11(fo/o)	2222:2397:5:A::/64	16.0.1.36/30
R11(fo/i) ->R12(fo/o)	2222:2397:5:B::/64	16.0.1.40/30
A3-R1(g5/o) ->B2-R2(g6/o)	2222:2397:4:4::2/64	15.0.1.14/30
A3-R1(g3/o) ->A2-R4(g3/o)	2222:2397:3:6::2/64	14.0.1.22/30
A3-R1(g4/o) ->A2-R3(g4/o)	2222:2397:3:7::2/64	14.0.1.26/30
A3-R3(g5/o) ->A2-R3(g3/o)	2222:2397:3:8::2/64	14.0.1.30/30
A3-R3(g3/o) ->B2-R2(g3/o)	2222:2397:4:5::2/64	15.0.1.18/30
A3-R3(g4/o) ->B2-R2(g4/o)	2222:2397:4:6::2/64	15.0.1.22/30
R4(f3/o) ->R18(fo/i)	-	16.0.1.46/30
R4(f2/i) ->R19(fo/i)	-	192.168.0.1/30
R4(L1)	-	16.16.16.1/32
R7(fi/o) ->R20(fo/i)	-	192.168.0.5/30
R7(L1)	-	16.16.16.2/32
Link-Local	FE80::1::X	

- Sede

R18(internet)	
-fo/o	172.16.2.4
-fo/1(r4)	16.0.1.45
ServerSede	172.16.2.3
ClienteSede	DHCP
R19	
-fo/o	172.16.2.1/24
-fo/1(r4)	192.168.0.2/30
-Lo	172.16.0.1/32

- Filial

R20	
-fo/o	172.16.3.1/24
-fo/1	192.168.0.6/32
-Lo	172.16.0.2/32
ClienteFilial	DHCP



## Tipos de configurações efetuadas

### ❖ IGP

#### ➤ Tier 1 A

- OSPFv3 AF single área (o)

#### ➤ Tier 1 B

- OSPFv3 AF multiárea o e 1

#### ➤ Tier 2 A

- OSPFv3 AF single área (o)

#### ➤ Tier 2 B

-rip (ipv4 e ipv6)

#### ➤ Tier 3 A

- OSPFv3 AF multiárea e ospf:

-area 0 -> Standard

-area 1 -> Totally stub

-area 2 -> Totally stub

-area 3 -> Transit

-area 4 -> virtual link

-area 5 -> Standard

-OSPF 2:

-Implementado no router A3-R4(PE) para conhecimento das redes da Sede, por conta da VPN L3 MPLS.

-Implementado no router A3-R7(PE) para conhecimento das redes da Filial, por conta da VPN L3 MPLS.

## ➤ Sede e Filial

-R18->

-Assegura a conectividade à internet para qualquer equipamento dentro da empresa a partir de rotas por omissão.

-Implementação de Nat

-Implementação de router rip para conhecimento das redes da empresa, para haver redirecionamento.

-r19->

-Implementação de rip com o A3-R4(PE) para a criação da VPN L3 MPLS, para este conhecer e aprender as rotas.

-Implementação de Dhcp dentro da Sede

-R20->

-Implementação de ospf com o router A3R7 (PE) para a criação da VPN L3 MPLS, para este conhecer e aprender as rotas.

-Implementação de Dhcp dentro da Filial

## ❖ BGP

### ➤ Tier 1 A

-eBGP;

-iBGP;

-A1-R2 -> Router reflector

-BGP PathAttributes ->Local Preference

-120->rotas aprendidas via Tier 2 A. (Link preferencial para comunicação todos os tiers menos o Tier 1 B) e uso paralelo dos links.

-140-> rotas aprendidas via Tier 1 B com destino ao AS6001, pelo router A1-R3 e uso paralelo dos links. (Link preferencial para comunicação com o Tier 1 B)

-130-> rotas aprendidas via Tier 1 B com destino ao AS6001, pelo router A1-R4 e uso paralelo dos links.

### ➤ Tier 1 B

-eBGP;

-iBGP;

-B1-R3 -> Router reflector

-BGP PathAttributes ->Local Preference

-140-> rotas aprendidas via Tier 1 A com destino ao AS6000, pelo router B1-R1 e uso paralelo dos links. (Link preferencial para comunicação com o Tier 1 A).

-130-> rotas aprendidas via Tier 1 A com destino ao AS6000, pelo router B1-R2 e uso paralelo dos links.

-120->rotas aprendidas via Tier 2 B. (Link preferencial para comunicação todos os Tiers menos o Tier 1 A) e uso paralelo dos links.

### ➤ Tier 2 A

-eBGP;

-iBGP;

-A2-R2 -> Router reflector

-BGP PathAttributes ->Local Preference

-120->rotas aprendidas via Tier 1 A com destino aos Tiers 1 pelo router A2-R1 (Link preferencial para comunicação com os Tiers 1) e uso paralelo dos links.

### ➤ Tier 2 B

-eBGP;

-iBGP;

-B2-R3 -> Router reflector

-BGP PathAttributes ->Local Preference

-120->rotas aprendidas via Tier 1 B com destino aos Tiers 1 pelo router B2-R1 (Link preferencial para comunicação com os Tiers 1) e uso paralelo dos links.

-Uso paralelo dos links nas ligações com o Tier 3 A

### ➤ Tier 3 A

-eBGP;

-iBGP;

-Confederação 1 e 2

-A3-R4 -> Router reflector da confederação 1

-A3-R7 -> Router reflector da confederação 2

-BGP PathAttributes ->Local Preference

-120->rotas aprendidas via Tier 2A (Link preferencial para comunicação com todos os Tiers) e uso paralelo dos links.

-QoS -> em todo o sistema autónomo

Classe (MARCAR)	Critérios	Precedência IP	MPLS EXP	Tratamento (QOS_SAIDA)
PRIORITARIO	DNS, ICMP, HTTP	5	5	Largura de banda garantida (10%) - GOLD
GESTAO	TELNET, SSH	3	3	Largura de banda garantida (20%) - SILVER
TRANSFERENCIA	TFTP	2	2	Largura de banda garantida (40%) - BRONZE
class-default	Não categorizado	0	0	Fair-Queue

-MPLS -> em todos o sistema autónomo

- VPN L3 MPLS -> para ligação entre a Sede e a Filial

- VRFs nos routers A3R4 e A3R7 para a VPN do cliente A

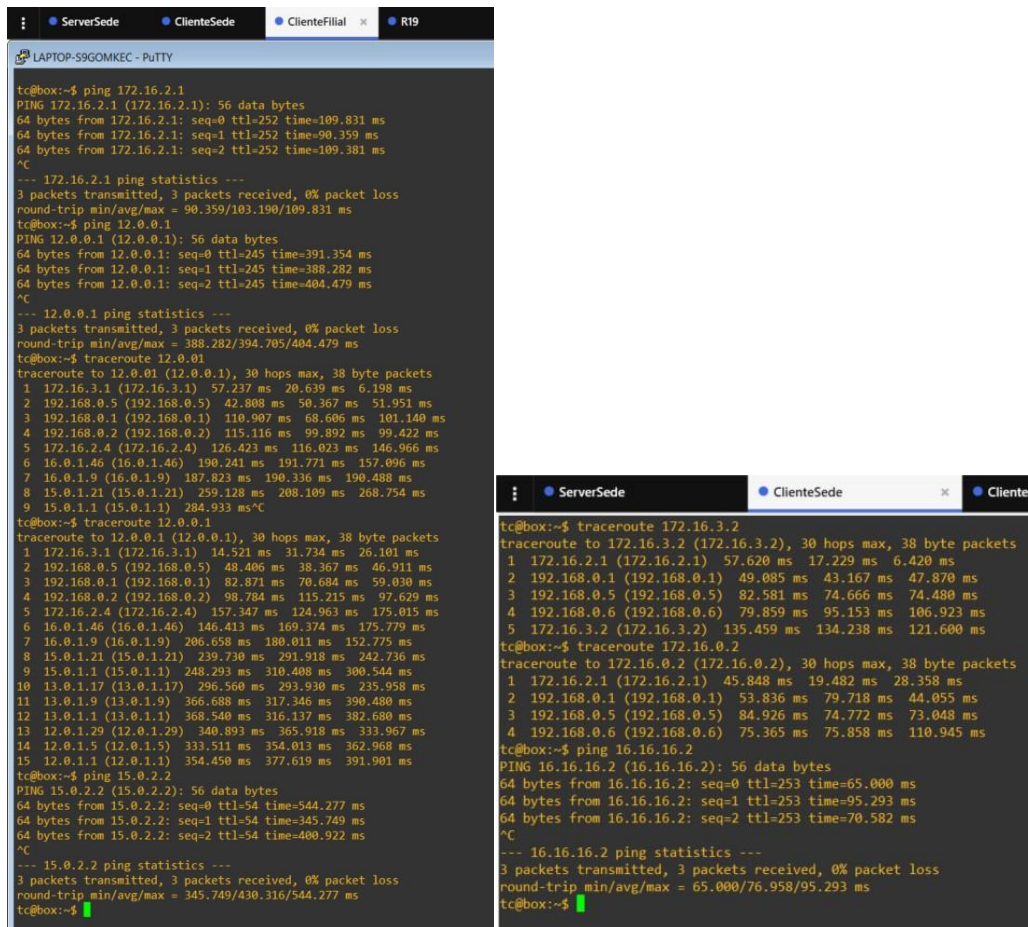
### ➤ Sede e Filial

-QoS ->cliente empresarial

Classe (MARCAR)	Critérios	Precedência IP	MPLS EXP	Tratamento (QOS_SAIDA_EMPRESA)
PRIORITARIO	DNS, ICMP, HTTP	5	5	Largura de banda garantida (10%) - GOLD
GESTAO	TELNET, SSH	3	3	Largura de banda garantida (20%) - SILVER
TRANSFERENCIA	TFTP	2	2	Largura de banda garantida (25%) - BRONZE

# TESTES DE CONECTIVIDADE

## ➤ VPN L3 MPLS



```
tc@box:~$ ping 172.16.2.1
PING 172.16.2.1 (172.16.2.1): 56 data bytes
64 bytes from 172.16.2.1: seq=0 ttl=252 time=109.831 ms
64 bytes from 172.16.2.1: seq=1 ttl=252 time=90.359 ms
64 bytes from 172.16.2.1: seq=2 ttl=252 time=109.381 ms
^C
--- 172.16.2.1 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 90.359/103.190/109.831 ms
tc@box:~$ ping 12.0.0.1
PING 12.0.0.1 (12.0.0.1): 56 data bytes
64 bytes from 12.0.0.1: seq=0 ttl=245 time=301.354 ms
64 bytes from 12.0.0.1: seq=1 ttl=245 time=388.282 ms
64 bytes from 12.0.0.1: seq=2 ttl=245 time=404.479 ms
^C
--- 12.0.0.1 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 388.282/394.705/404.479 ms
tc@box:~$ traceroute 12.0.0.1
traceroute to 12.0.0.1 (12.0.0.1), 30 hops max, 38 byte packets
 1 172.16.3.1 (172.16.3.1) 57.237 ms 20.639 ms 6.198 ms
 2 192.168.0.5 (192.168.0.5) 42.808 ms 50.367 ms 51.951 ms
 3 192.168.0.1 (192.168.0.1) 110.907 ms 68.606 ms 101.140 ms
 4 192.168.0.2 (192.168.0.2) 115.116 ms 90.892 ms 99.422 ms
 5 172.16.2.4 (172.16.2.4) 126.423 ms 116.023 ms 146.966 ms
 6 16.0.1.46 (16.0.1.46) 190.241 ms 191.771 ms 157.096 ms
 7 16.0.1.9 (16.0.1.9) 187.823 ms 190.336 ms 190.488 ms
 8 15.0.1.21 (15.0.1.21) 259.128 ms 208.109 ms 268.754 ms
 9 15.0.1.1 (15.0.1.1) 284.933 ms^C
tc@box:~$ traceroute 12.0.0.1
traceroute to 12.0.0.1 (12.0.0.1), 30 hops max, 38 byte packets
 1 172.16.3.1 (172.16.3.1) 14.521 ms 31.734 ms 26.101 ms
 2 192.168.0.5 (192.168.0.5) 48.406 ms 38.367 ms 46.911 ms
 3 192.168.0.1 (192.168.0.1) 82.871 ms 70.684 ms 59.030 ms
 4 192.168.0.2 (192.168.0.2) 98.784 ms 115.215 ms 97.629 ms
 5 172.16.2.4 (172.16.2.4) 157.347 ms 124.963 ms 175.015 ms
 6 16.0.1.46 (16.0.1.46) 146.413 ms 169.374 ms 175.779 ms
 7 16.0.1.9 (16.0.1.9) 206.658 ms 180.011 ms 152.775 ms
 8 15.0.1.21 (15.0.1.21) 239.720 ms 201.910 ms 242.736 ms
 9 15.0.1.1 (15.0.1.1) 248.293 ms 310.408 ms 300.544 ms
10 13.0.1.17 (13.0.1.17) 296.560 ms 293.930 ms 235.958 ms
11 13.0.1.9 (13.0.1.9) 366.688 ms 317.346 ms 390.480 ms
12 13.0.1.1 (13.0.1.1) 368.540 ms 316.137 ms 382.680 ms
13 12.0.1.29 (12.0.1.29) 340.893 ms 365.918 ms 333.967 ms
14 12.0.1.5 (12.0.1.5) 333.511 ms 354.013 ms 362.968 ms
15 12.0.1.1 (12.0.1.1) 354.450 ms 377.619 ms 391.901 ms
tc@box:~$ ping 15.0.2.2
PING 15.0.2.2 (15.0.2.2): 56 data bytes
64 bytes from 15.0.2.2: seq=0 ttl=54 time=544.277 ms
64 bytes from 15.0.2.2: seq=1 ttl=54 time=345.749 ms
64 bytes from 15.0.2.2: seq=2 ttl=54 time=400.922 ms
^C
--- 15.0.2.2 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 345.749/430.316/544.277 ms
tc@box:~$
```

```
tc@box:~$ traceroute 172.16.3.2
traceroute to 172.16.3.2 (172.16.3.2), 30 hops max, 38 byte packets
 1 172.16.2.1 (172.16.2.1) 57.620 ms 17.229 ms 6.420 ms
 2 192.168.0.1 (192.168.0.1) 49.085 ms 43.167 ms 47.870 ms
 3 192.168.0.5 (192.168.0.5) 82.581 ms 74.666 ms 74.480 ms
 4 192.168.0.6 (192.168.0.6) 79.859 ms 95.153 ms 106.923 ms
 5 172.16.3.2 (172.16.3.2) 135.459 ms 134.238 ms 121.600 ms
tc@box:~$ traceroute 172.16.0.2
traceroute to 172.16.0.2 (172.16.0.2), 30 hops max, 38 byte packets
 1 172.16.2.1 (172.16.2.1) 45.848 ms 19.482 ms 28.358 ms
 2 192.168.0.1 (192.168.0.1) 53.836 ms 79.718 ms 44.055 ms
 3 192.168.0.5 (192.168.0.5) 84.926 ms 74.772 ms 73.048 ms
 4 192.168.0.6 (192.168.0.6) 75.365 ms 75.858 ms 110.945 ms
tc@box:~$ ping 16.16.16.2
PING 16.16.16.2 (16.16.16.2): 56 data bytes
64 bytes from 16.16.16.2: seq=0 ttl=253 time=65.000 ms
64 bytes from 16.16.16.2: seq=1 ttl=253 time=95.293 ms
64 bytes from 16.16.16.2: seq=2 ttl=253 time=70.582 ms
^C
--- 16.16.16.2 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 65.000/76.958/95.293 ms
tc@box:~$
```

Figura 1- ClienteFilial-ServerAS9002 e ClienteSede-Filial

```
ServerSede  ClienteSede  ClienteFiliat
LAPTOP-S9GOMKEC - PuTTY

47 packets transmitted, 0 packets received, 100% packet loss
tc@box:~$ ping 172.16.2.1
PING 172.16.2.1 (172.16.2.1): 56 data bytes
64 bytes from 172.16.2.1: seq=0 ttl=252 time=93.086 ms
64 bytes from 172.16.2.1: seq=1 ttl=252 time=105.151 ms
64 bytes from 172.16.2.1: seq=2 ttl=252 time=107.599 ms
^C
-- 172.16.2.1 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 93.086/101.945/107.599 ms
tc@box:~$ ping 172.16.2.1
PING 172.16.2.1 (172.16.2.1): 56 data bytes
64 bytes from 172.16.2.1: seq=0 ttl=252 time=109.831 ms
64 bytes from 172.16.2.1: seq=1 ttl=252 time=90.359 ms
64 bytes from 172.16.2.1: seq=2 ttl=252 time=109.381 ms
^C
-- 172.16.2.1 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 90.359/103.190/109.831 ms
tc@box:~$ ping 12.0.0.1
PING 12.0.0.1 (12.0.0.1): 56 data bytes
64 bytes from 12.0.0.1: seq=0 ttl=245 time=391.354 ms
64 bytes from 12.0.0.1: seq=1 ttl=245 time=388.282 ms
64 bytes from 12.0.0.1: seq=2 ttl=245 time=404.479 ms
^C
-- 12.0.0.1 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 388.282/394.705/404.479 ms
tc@box:~$ traceroute 12.0.0.1
traceroute to 12.0.0.1 (12.0.0.1), 30 hops max, 38 byte packets
 1 172.16.3.1 (172.16.3.1) 57.237 ms 20.639 ms 6.198 ms
 2 192.168.0.5 (192.168.0.5) 42.808 ms 50.367 ms 51.951 ms
 3 192.168.0.1 (192.168.0.1) 110.907 ms 68.606 ms 101.140 ms
 4 192.168.0.2 (192.168.0.2) 115.116 ms 99.892 ms 99.422 ms
 5 172.16.2.4 (172.16.2.4) 126.493 ms 116.023 ms 146.966 ms
 6 16.0.1.46 (16.0.1.46) 190.241 ms 191.771 ms 157.096 ms
 7 16.0.1.9 (16.0.1.9) 187.823 ms 190.336 ms 190.488 ms
 8 15.0.1.21 (15.0.1.21) 259.128 ms 208.109 ms 268.754 ms
 9 15.0.1.1 (15.0.1.1) 284.933 ms^C
tc@box:~$ traceroute 12.0.0.1
traceroute to 12.0.0.1 (12.0.0.1), 30 hops max, 38 byte packets
 1 172.16.3.1 (172.16.3.1) 14.521 ms 31.734 ms 26.101 ms
 2 192.168.0.5 (192.168.0.5) 40.408 ms 38.367 ms 46.911 ms
 3 192.168.0.1 (192.168.0.1) 82.871 ms 70.684 ms 59.030 ms
 4 192.168.0.2 (192.168.0.2) 90.784 ms 115.215 ms 97.629 ms
 5 172.16.2.4 (172.16.2.4) 157.347 ms 124.963 ms 175.015 ms
 6 16.0.1.46 (16.0.1.46) 146.413 ms 169.374 ms 175.779 ms
 7 16.0.1.9 (16.0.1.9) 206.658 ms 180.011 ms 152.775 ms
 8 15.0.1.21 (15.0.1.21) 239.730 ms 291.918 ms 242.736 ms
 9 15.0.1.1 (15.0.1.1) 248.293 ms 310.408 ms 300.544 ms
10 13.0.1.17 (13.0.1.17) 296.560 ms 293.930 ms 235.958 ms
11 13.0.1.9 (13.0.1.9) 366.608 ms 317.346 ms 390.480 ms
12 13.0.1.1 (13.0.1.1) 368.540 ms 316.137 ms 382.680 ms
13 12.0.1.29 (12.0.1.29) 340.893 ms 365.918 ms 333.967 ms
14 12.0.1.5 (12.0.1.5) 333.511 ms 354.013 ms 362.968 ms
15 12.0.1.1 (12.0.1.1) 354.450 ms 377.619 ms 391.901 ms
tc@box:~$
```

Figura 2- ClienteFiliat-Internet (Tier 1 A)

```

A3-R7#traceroute vrf A 12.0.0.1
Type escape sequence to abort.
Tracing the route to 12.0.0.1
VRF info: (vrf in name/id, vrf out name/id)
 1 192.168.0.1 68 msec 56 msec 0 msec
 2 192.168.0.2 60 msec 40 msec 32 msec
 3 172.16.2.4 72 msec 124 msec 56 msec
 4 16.0.1.46 [AS 1] 120 msec 100 msec 88 msec
 5 16.0.1.9 [AS 1] 168 msec 148 msec 156 msec
 6 15.0.1.21 [AS 9002] 172 msec 160 msec 140 msec
 7 15.0.1.1 [AS 9002] 168 msec 184 msec 196 msec
 8 13.0.1.17 [AS 6001] 232 msec 244 msec 208 msec
 9 13.0.1.9 [AS 6001] 252 msec 244 msec 248 msec
10 13.0.1.1 [AS 6001] 256 msec 244 msec 232 msec
11 12.0.1.29 [AS 6000] 272 msec 256 msec 292 msec
12 12.0.1.5 [AS 6000] 288 msec 296 msec 236 msec
13 12.0.1.1 [AS 6000] 248 msec 256 msec 288 msec
A3-R7#sh mpls forwarding-table vrf A
Local   Outgoing  Prefix      Bytes Label  Outgoing  Next Hop
Label   Label     or Tunnel Id Switched     Interface
7018    Pop Label  16.16.16.2/32[V] 7340         aggregate/A
7019    No Label   172.16.0.2/32[V] 0             Fa1/0       192.168.0.6
7020    No Label   172.16.3.0/24[V] 0             Fa1/0       192.168.0.6
7021    No Label   192.168.0.4/30[V] \              0
                                aggregate/A

A3-R7#sh ip vr
A3-R7#sh ip rpu
A3-R7#sh ip rou
A3-R7#sh ip route vr
A3-R7#sh ip route vrf A

Routing Table: A
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is 16.16.16.1 to network 0.0.0.0

S*  0.0.0.0/0 [1/0] via 16.16.16.1
B   16.0.0.0/32 is subnetted, 2 subnets
B   16.16.16.1 [200/0] via 16.0.0.4, 00:03:50
C   16.16.16.2 is directly connected, Loopback1
C   172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
B   172.16.0.1/32 [200/100] via 16.0.0.4, 00:04:50
O E2 172.16.0.2/32 [110/20] via 192.168.0.6, 00:05:15, FastEthernet1/0
B   172.16.2.0/24 [200/100] via 16.0.0.4, 00:04:50
O E2 172.16.3.0/24 [110/20] via 192.168.0.6, 00:05:15, FastEthernet1/0
    192.168.0.0/24 is variably subnetted, 3 subnets, 2 masks
B   192.168.0.0/30 [200/0] via 16.0.0.4, 00:04:50
C   192.168.0.4/30 is directly connected, FastEthernet1/0
L   192.168.0.5/32 is directly connected, FastEthernet1/0
A3-R7#

```

Figura 3- VPN L3 MPLS e visionamento do tráfego escolhido

- QOS
- Tier 3 A

```

2 16.0.1.2 [AS 10001] 136 msec 180 msec 236 msec
B2-R2#ping 16.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 16.0.0.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 136/171/240 ms
B2-R2#

```

```

A3-R1#show policy-map interface gigabitEthernet 5/0
GigabitEthernet5/0

Service-policy input: MARCAR

Class-map: PRIORITARIO (match-any)
  5 packets, 570 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: access-group name DNS
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: access-group name ICMP
    5 packets, 570 bytes
    5 minute rate 0 bps
  Match: access-group name HTTP
    0 packets, 0 bytes
    5 minute rate 0 bps
  QoS Set
    precedence 5
    Packets marked 5
    mpls experimental topmost 5
    Packets marked 0

Class-map: GESTAO (match-any)
  0 packets, 0 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: access-group name TELNET
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: access-group name SSH
    0 packets, 0 bytes
    5 minute rate 0 bps
  QoS Set
    precedence 3
    Packets marked 0
    mpls experimental topmost 3
    Packets marked 0

Class-map: TRANSFERENCIA (match-all)
  0 packets, 0 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: protocol tftp
  QoS Set
    precedence 2
    Packets marked 0
    mpls experimental topmost 2
    Packets marked 0

```

Figura 4- Qos-MARCAR-TIER 2 A (ping)



## ○ VPN L3 MPLS

```
R20#ping 12.0.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 476/542/612 ms
R20#sh policy-map interface fastEthernet 0/1
FastEthernet0/1

Service-policy output: QOS_SAIDA

queue stats for all priority classes:
  Queueing
  queue limit 64 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 5/570

Class-map: PRIORITARIO (match-any)
  5 packets, 570 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: access-group name DNS
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: access-group name ICMP
    5 packets, 570 bytes
    5 minute rate 0 bps
  Match: access-group name HTTP
    0 packets, 0 bytes
    5 minute rate 0 bps
  Priority: 10% (10000 kbps), burst bytes 250000, b/w exceed drops: 0

Class-map: GESTAO (match-any)
  0 packets, 0 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: access-group name TELNET
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: access-group name SSH
    0 packets, 0 bytes
    5 minute rate 0 bps
  Queueing
  queue limit 64 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 0/0
  bandwidth 20% (20000 kbps)

Class-map: TRANSFERENCIA (match-all)
  0 packets, 0 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: protocol tftp
  Queueing
  queue limit 64 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 0/0
  bandwidth 25% (25000 kbps)

Class-map: class-default (match-any)
  475 packets, 47681 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: any

Service-policy output: QOS_SAIDA

queue stats for all priority classes:
  Queueing
  queue limit 64 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 5/610

Class-map: GOLD (match-any)
  5 packets, 610 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: ip precedence 5
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: mpls experimental topmost 5
    5 packets, 610 bytes
    5 minute rate 0 bps
  Priority: 10% (10000 kbps), burst bytes 250000, b/w exceed drops: 0

Class-map: SILVER (match-any)
  0 packets, 0 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: ip precedence 3
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: mpls experimental topmost 3
    0 packets, 0 bytes
    5 minute rate 0 bps
  Queueing
  queue limit 64 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 0/0
  bandwidth 20% (20000 kbps)

Class-map: BRONZE (match-any)
  0 packets, 0 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: ip precedence 2
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: mpls experimental topmost 2
    0 packets, 0 bytes
    5 minute rate 0 bps
  Queueing
  queue limit 64 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 0/0
  bandwidth 40% (40000 kbps)

Class-map: class-default (match-any)
  477 packets, 38421 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: any
  Queueing
  queue limit 64 packets
  (queue depth/total drops/no-buffer drops/flowdrops) 0/0/0/0
  (pkts output/bytes output) 477/40283
  Fair-queue: per-flow queue limit 16 packets
```

Figura 5- QOS na VPN entre os routers do Tier 3 A (ping)

```

R19#telnet 16.16.16.1
Trying 16.16.16.1 ... Open

Password required, but none set
[Connection to 16.16.16.1 closed by foreign host]
R19#show policy-map interface 2/1
^
% Invalid input detected at '^' marker.

R19#show policy-map interface f2/1
R19#show policy-map interface fas
R19#show policy-map interface fastEthernet 2/1
R19#show policy-map interface fastEthernet 0/1
FastEthernet0/1

Service-policy output: QOS_SAIDA

queue stats for all priority classes:

Queueing
queue limit 64 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 5/570

Class-map: PRIORITARIO (match-any)
  5 packets, 570 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: access-group name DNS
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: access-group name ICMP
    5 packets, 570 bytes
    5 minute rate 0 bps
  Match: access-group name HTTP
    0 packets, 0 bytes
    5 minute rate 0 bps
  Priority: 10% (10000 kbps), burst bytes 250000, b/w exceed drops: 0

Class-map: GESTAO (match-any)
  10 packets, 606 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: access-group name TELNET
    10 packets, 606 bytes
    5 minute rate 0 bps
  Match: access-group name SSH
    0 packets, 0 bytes
    5 minute rate 0 bps
  Queueing
  queue limit 64 packets
  (queue depth/total drops/no-buffer drops) 0/0/0
  (pkts output/bytes output) 10/606
  bandwidth 20% (20000 kbps)

Class-map: TRANSFERENCIA (match-all)
  0 packets, 0 bytes
  5 minute offered rate 0000 bps, drop rate 0000 bps
  Match: protocol tftp

```

Figura 6- Qos pacote telnet identificado na saída R19

## ➤ BGP E IGP

### ○ Tier 1 A

```

A1-R1#sh bgp
BGP table version is 11, local router ID is 6.6.6.6
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
* i 12.0.0.0/16    12.0.0.3             0      100    0 ?
*>  0.0.0.0        0.0.0.0              0      32768 ?
*> i 13.0.0.0/16    12.0.0.3             0      140    0 6001 ?
*m 14.0.0.0/16     12.0.1.22            0      120    0 9001 ?
*>  12.0.1.18      12.0.1.18            0      120    0 9001 ?
*m 15.0.0.0/16     12.0.1.22            120    0 9001 10001 9002 ?
*>  12.0.1.18      12.0.1.18            120    0 9001 10001 9002 ?
*m 16.0.0.0/16     12.0.1.22            120    0 9001 10001 ?
*>  12.0.1.18      12.0.1.18            120    0 9001 10001 ?

A1-R1#sh bgp ipv
A1-R1#sh bgp ipv6
BGP table version is 10, local router ID is 6.6.6.6
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
* i 2222:2397:1::/48 2222:2397:1::3       0      100    0 ?
*>  ::              ::                  0      32768 ?
*> i 2222:2397:2::/48 2222:2397:1::3       0      140    0 6001 ?
*> 2222:2397:3::/48 2222:2397:1:5::2     0      120    0 9001 ?
*m  2222:2397:1:6::2 0      120    0 9001 ?
*m 2222:2397:4::/48 2222:2397:1:6::2    120    0 9001 10001 9002 ?
*>  2222:2397:1:5::2 120    0 9001 10001 9002 ?
*m 2222:2397:5::/48 2222:2397:1:6::2    120    0 9001 10001 ?
*>  2222:2397:1:5::2 120    0 9001 10001 ?

   Network        Next Hop           Metric LocPrf Weight Path
*>  2222:2397:1:5::2 120    0 9001 10001 ?

% NOTE: This command is deprecated. Please use 'show bgp ipv6 unicast'
A1-R1#

```

Figura 7- Tier 1 A escolha das rotas BGP

```

A1-R3#sh ipw6 route
IPv6 Routing Table - default - 19 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
        B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
        H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
        IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
        ND - ND Default, NDP - ND Prefix, DCE - Destination, NDR - Redirect
        O - OSPF Inttra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
        ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, L - LISP
S    2222:2397:1::/48 [1/0]
    via Null0, directly connected
O    2222:2397:1:1::/128 [110/2]
    via FE80::6000:2, FastEthernet0/1
O    2222:2397:1:2::/128 [110/1]
    via FE80::6000:2, FastEthernet0/1
LC   2222:2397:1:3::/128 [0/0]
    via Loopback0, receive
O    2222:2397:1:4::/128 [110/2]
    via FE80::6000:2, FastEthernet0/1
O    2222:2397:1:1::/64 [110/2]
    via FE80::6000:2, FastEthernet0/1
C    2222:2397:1:2::/64 [0/0]
    via FastEthernet0/1, directly connected
L    2222:2397:1:2:2/128 [0/0]
    via FastEthernet0/1, receive
O    2222:2397:1:3::/64 [110/2]
    via FE80::6000:2, FastEthernet0/1
O    2222:2397:1:4::/64 [110/3]
    via FE80::6000:2, FastEthernet0/1
C    2222:2397:1:7::/64 [0/0]
    via GigabitEthernet3/0, directly connected
L    2222:2397:1:7:1/128 [0/0]
    via GigabitEthernet3/0, receive
C    2222:2397:1:8::/64 [0/0]
    via GigabitEthernet4/0, directly connected
L    2222:2397:1:8:1/128 [0/0]
    via GigabitEthernet4/0, receive
B    2222:2397:2::/48 [20/0]
    via FE80::6001:1, GigabitEthernet3/0
    via FE80::6001:1, GigabitEthernet4/0
B    2222:2397:3::/48 [200/0]
    via 2222:2397:1:1
B    2222:2397:4::/48 [200/0]
    via 2222:2397:1:1
B    2222:2397:5::/48 [200/0]
    via 2222:2397:1:1
L    FE00::/8 [0/0]
    via Null0, receive
A1-R3#

```

```

A1-R3#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
        D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default, U - per-user static route
        o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
        + - replicated route, % - next hop override

Gateway of last resort is not set

    12.0.0.0/8 is variably subnetted, 14 subnets, 3 masks
S    12.0.0.0/16 is directly connected, Null0
O    12.0.0.1/32 [110/2] via 12.0.1.5, 00:08:10, FastEthernet0/1
O    12.0.0.2/32 [110/1] via 12.0.1.5, 00:08:10, FastEthernet0/1
C    12.0.0.3/32 is directly connected, Loopback0
O    12.0.0.4/32 [110/2] via 12.0.1.5, 00:08:10, FastEthernet0/1
O    12.0.1.0/30 [110/2] via 12.0.1.5, 00:08:10, FastEthernet0/1
C    12.0.1.4/30 is directly connected, FastEthernet0/1
L    12.0.1.6/32 is directly connected, FastEthernet0/1
O    12.0.1.8/30 [110/2] via 12.0.1.5, 00:08:10, FastEthernet0/1
O    12.0.1.12/30 [110/3] via 12.0.1.5, 00:08:10, FastEthernet0/1
C    12.0.1.24/30 is directly connected, GigabitEthernet3/0
L    12.0.1.25/32 is directly connected, GigabitEthernet3/0
C    12.0.1.28/30 is directly connected, GigabitEthernet4/0
L    12.0.1.29/32 is directly connected, GigabitEthernet4/0
B    13.0.0.0/16 is subnetted, 1 subnets
    13.0.0.0 [20/0] via 12.0.1.30, 00:08:06
    [20/0] via 12.0.1.26, 00:08:06
B    14.0.0.0/16 is subnetted, 1 subnets
    14.0.0.0 [200/0] via 12.0.0.1, 00:08:01
B    15.0.0.0/16 is subnetted, 1 subnets
    15.0.0.0 [200/0] via 12.0.0.1, 00:07:36
B    16.0.0.0/16 is subnetted, 1 subnets
    16.0.0.0 [200/0] via 12.0.0.1, 00:07:36
A1-R3#

```

Figura 8- Rotas

## ○ Tier 1 B

```

B1-R2#sh bgp ipv6 unicast
BGP table version is 15, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop        Metric LocPrf Weight Path
*    2222:2397:1::/48  2222:2397:2:7::2
                                     0 9001 6000 ?
*>i    2222:2397:2::1
                                     0 140 0 6000 ?
*    2222:2397:1:9::1
                                     0 130 0 6000 ?
*    2222:2397:1:A::1
                                     0 130 0 6000 ?
* i 2222:2397:2::/48  2222:2397:2::1
                                     0 100 0 ?
*>    2222:2397:3::/48  2222:2397:2::4
                                     0 32768 ?
*>i 2222:2397:3::/48  2222:2397:2::4
                                     0 120 0 9002 6000 9001 ?
*    2222:2397:2:7::2
                                     0 9001 ?
*>i 2222:2397:4::/48  2222:2397:2::4
                                     0 120 0 9002 ?
*>i 2222:2397:5::/48  2222:2397:2::4
                                     0 120 0 9002 10001 ?
*    2222:2397:2:7::2
                                     0 9001 10001 ?

   Network          Next Hop        Metric LocPrf Weight Path
*    12.0.0.0/16     13.0.1.26
                                     0 9001 6000 ?
*>i    13.0.0.1
                                     0 140 0 6000 ?
*    12.0.1.33
                                     0 130 0 6000 ?
*    12.0.1.37
                                     0 130 0 6000 ?
* i 13.0.0.0/16     13.0.0.1
                                     0 100 0 ?
*>    0.0.0.0
                                     0 32768 ?
*>i 14.0.0.0/16     13.0.0.4
                                     0 120 0 9002 6000 9001 ?
*    13.0.1.26
                                     0 9001 ?
*>i 15.0.0.0/16     13.0.0.4
                                     0 120 0 9002 ?
*>i 16.0.0.0/16     13.0.0.4
                                     0 120 0 9002 10001 ?
*    13.0.1.26
                                     0 9001 10001 ?
B1-R2#

```

Figura 9- Tier 1 B escolha das rotas BGP

```

B1-R4#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHRP, I - IIS
+ - replicated route, % - next hop override

Gateway of last resort is not set

12.0.0.0/16 is subnetted, 1 subnets
B 12.0.0.0 [200/0] via 13.0.0.1, 00:07:29
13.0.0.0/8 is variably subnetted, 15 subnets, 3 masks
S 13.0.0.0/16 is directly connected, Null0
O IA 13.0.0.1/32 [110/2] via 13.0.1.9, 00:07:38, FastEthernet0/0
O IA 13.0.0.2/32 [110/1] via 13.0.1.13, 00:07:43, FastEthernet0/1
O IA 13.0.0.3/32 [110/1] via 13.0.1.9, 00:07:44, FastEthernet0/0
C 13.0.0.4/32 is directly connected, Loopback0
O IA 13.0.1.0/30 [110/2] via 13.0.1.9, 00:07:44, FastEthernet0/0
O IA 13.0.1.4/30 [110/2] via 13.0.1.13, 00:07:44, FastEthernet0/1
13.0.1.8/30 is directly connected, FastEthernet0/0
L 13.0.1.10/32 is directly connected, FastEthernet0/0
C 13.0.1.12/30 is directly connected, FastEthernet0/1
L 13.0.1.14/32 is directly connected, FastEthernet0/1
C 13.0.1.16/30 is directly connected, GigabitEthernet3/0
L 13.0.1.17/32 is directly connected, GigabitEthernet3/0
C 13.0.1.20/30 is directly connected, GigabitEthernet4/0
L 13.0.1.21/32 is directly connected, GigabitEthernet4/0
14.0.0.0/16 is subnetted, 1 subnets
B 14.0.0.0 [200/0] via 13.0.1.22, 00:06:55
15.0.0.0/16 is subnetted, 1 subnets
B 15.0.0.0 [200/0] via 13.0.1.22, 00:07:27
16.0.0.0/16 is subnetted, 1 subnets
B 16.0.0.0 [200/0] via 13.0.1.22, 00:06:55
B1-R4#

```

```

B1-R4#sh ipv6 route
IPv6 Routing Table - default - 20 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, 1 - LISP
B 2222:2397:1::/48 [200/0]
via 2222:2397:2::1
S 2222:2397:2::/48 [1/0]
via Null0, directly connected
OI 2222:2397:2::1/128 [110/2]
via FE80::6001:3, FastEthernet0/0
OI 2222:2397:2::2/128 [110/1]
via FE80::6001:2, FastEthernet0/1
OI 2222:2397:2::3/128 [110/1]
via FE80::6001:3, FastEthernet0/0
LC 2222:2397:2::4/128 [0/0]
via Loopback0, receive
OI 2222:2397:2:1::/64 [110/2]
via FE80::6001:3, FastEthernet0/0
OI 2222:2397:2:2::/64 [110/2]
via FE80::6001:2, FastEthernet0/1
via FE80::6001:3, FastEthernet0/0
C 2222:2397:2:3::/64 [0/0]
via FastEthernet0/0, directly connected
L 2222:2397:2:3::2/128 [0/0]
via FastEthernet0/0, receive
C 2222:2397:2:4::/64 [0/0]
via FastEthernet0/1, directly connected
L 2222:2397:2:4::2/128 [0/0]
via FastEthernet0/1, receive
C 2222:2397:2:5::/64 [0/0]
via GigabitEthernet3/0, directly connected
L 2222:2397:2:5::1/128 [0/0]
via GigabitEthernet3/0, receive
C 2222:2397:2:6::/64 [0/0]
via GigabitEthernet4/0, directly connected
L 2222:2397:2:6::1/128 [0/0]
via GigabitEthernet4/0, receive
B 2222:2397:3::/48 [200/0]
via FE80::9002:1, GigabitEthernet4/0
via FE80::9002:1, GigabitEthernet3/0
B 2222:2397:4::/48 [200/0]
via FE80::9002:1, GigabitEthernet4/0
via FE80::9002:1, GigabitEthernet3/0
B 2222:2397:5::/48 [200/0]
via FE80::9002:1, GigabitEthernet4/0
via FE80::9002:1, GigabitEthernet3/0
L FF00::/8 [0/0]
via Null0, receive
B1-R4#

```

Figura 10- Rotas

## ○ Tier 2 A

```
A2-R2#sh bgp
BGP table version is 14, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
  *i 12.0.0.0/16   14.0.0.1             0 120 0 6000 ?
  *i 13.0.0.0/16   14.0.0.1             0 120 0 6000 6001 ?
  * i 14.0.0.0/16   14.0.0.4             0 100 0 ?
  * i 14.0.0.0/16   14.0.0.3             0 100 0 ?
  *i 15.0.0.0/16   14.0.0.4             0 100 0 10001 9002 ?
  * i 15.0.0.0/16   14.0.0.3             0 100 0 6001 9002 ?
  *i 16.0.0.0/16   14.0.0.4             0 100 0 10001 ?
  * i 16.0.0.0/16   14.0.0.3             0 100 0 10001 ?

A2-R2#sh bg
A2-R2#sh bgp ipv6
A2-R2#sh bgp ipv6 unicast
BGP table version is 14, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
  *i 2222:2397:1::/48 2222:2397:3::1       0 120 0 6000 ?
  *i 2222:2397:2::/48 2222:2397:3::1       0 120 0 6000 6001 ?
  * i 2222:2397:3::/48 2222:2397:3::4       0 100 0 ?
  * i 2222:2397:3::/48 2222:2397:3::3       0 100 0 ?
  *i 2222:2397:3::/48 2222:2397:3::1       0 100 0 ?
  *i 2222:2397:4::/48 2222:2397:3::4       0 100 0 10001 9002 ?
  * i 2222:2397:4::/48 2222:2397:3::3       0 100 0 6001 9002 ?
  *i 2222:2397:5::/48 2222:2397:3::4       0 100 0 10001 ?
  * i 2222:2397:5::/48 2222:2397:3::3       0 100 0 10001 ?

A2-R2#
```

Figura 11- Tier 2 A escolha das rotas BGP

```
A2-R2#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, X - next hop override

Gateway of last resort is not set

12.0.0.0/16 is subnetted, 1 subnets
B 12.0.0.0 [200/0] via 14.0.0.1, 00:09:09
13.0.0.0/16 is subnetted, 1 subnets
B 13.0.0.0 [200/0] via 14.0.0.1, 00:08:42
14.0.0.0/8 is variably subnetted, 13 subnets, 3 masks
B 14.0.0.0/16 [200/0] via 14.0.0.1, 00:09:09
D 14.0.0.1/32 [110/1] via 14.0.1.1, 00:09:15, FastEthernet0/1
C 14.0.0.2/32 is directly connected, Loopback0
D 14.0.0.3/32 [110/1] via 14.0.1.14, 00:09:15, FastEthernet0/0
D 14.0.0.4/32 [110/1] via 14.0.1.18, 00:09:15, FastEthernet1/0
C 14.0.1.0/30 is directly connected, FastEthernet0/1
L 14.0.1.2/32 is directly connected, FastEthernet0/1
D 14.0.1.4/30 [110/2] via 14.0.1.14, 00:09:15, FastEthernet0/0
  [110/2] via 14.0.1.1, 00:09:15, FastEthernet0/1
O 14.0.1.8/30 [110/2] via 14.0.1.18, 00:09:15, FastEthernet1/0
  [110/2] via 14.0.1.1, 00:09:15, FastEthernet0/1
C 14.0.1.12/30 is directly connected, FastEthernet0/0
L 14.0.1.13/32 is directly connected, FastEthernet0/0
C 14.0.1.16/30 is directly connected, FastEthernet1/0
L 14.0.1.17/32 is directly connected, FastEthernet1/0
15.0.0.0/16 is subnetted, 1 subnets
B 15.0.0.0 [200/0] via 14.0.0.4, 00:01:10
16.0.0.0/16 is subnetted, 1 subnets
B 16.0.0.0 [200/0] via 14.0.0.4, 00:01:10

A2-R2#
```

```
A2-R2#sh ipv6 route
IPv6 Routing Table - default - 18 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, Ndp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, l - LISP
B 2222:2397:1::/48 [200/0]
  via 2222:2397:3::1
B 2222:2397:2::/48 [200/0]
  via 2222:2397:3::1
B 2222:2397:3::/48 [200/0]
  via 2222:2397:3::1
O 2222:2397:3:1/128 [110/1]
  via FE80::9001:1, FastEthernet0/1
LC 2222:2397:3:2/128 [0/0]
  via Loopback0, receive
O 2222:2397:3:3/128 [110/1]
  via FE80::9001:3, FastEthernet0/0
O 2222:2397:3:4/128 [110/1]
  via FE80::9001:4, FastEthernet1/0
C 2222:2397:3:1::/64 [0/0]
  via FastEthernet0/1, directly connected
L 2222:2397:3:1:2/128 [0/0]
  via FastEthernet0/1, receive
O 2222:2397:3:2::/64 [110/2]
  via FE80::9001:1, FastEthernet0/1
  via FE80::9001:3, FastEthernet0/0
O 2222:2397:3:3::/64 [110/2]
  via FE80::9001:1, FastEthernet0/1
  via FE80::9001:4, FastEthernet1/0
C 2222:2397:3:4::/64 [0/0]
  via FastEthernet0/0, directly connected
L 2222:2397:3:4:1/128 [0/0]
  via FastEthernet0/0, receive
C 2222:2397:3:5::/64 [0/0]
  via FastEthernet1/0, directly connected
L 2222:2397:3:5:1/128 [0/0]
  via FastEthernet1/0, receive
B 2222:2397:4::/48 [200/0]
  via 2222:2397:3:4
B 2222:2397:5::/48 [200/0]
  via 2222:2397:3:4
L FF00::/8 [0/0]
  via Null0, receive

A2-R2#
```

Figura 12- Rotas



## ○ Tier 2 B

```
B2-R3#sh bgp
BGP table version is 7, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
  *i 12.0.0.0/16   15.0.0.1             0    120    0 6001 6000 ?
  *i 13.0.0.0/16   15.0.0.1             0    120    0 6001 ?
  *i 14.0.0.0/16   15.0.0.2             0    100    0 10001 9001 ?
  r i 15.0.0.0/16   15.0.0.2             0    100    0 ?
  r> i 15.0.0.0/16  15.0.0.1             0    100    0 ?
  *i 16.0.0.0/16   15.0.0.2             0    100    0 10001 ?

B2-R3#sh bgp ipv6
BGP table version is 8, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
               x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network        Next Hop           Metric LocPrf Weight Path
  *i 2222:2397:1::/48 2222:2397:4::1       0    120    0 6001 6000 ?
  *i 2222:2397:2::/48 2222:2397:4::1       0    120    0 6001 ?
  *i 2222:2397:3::/48 2222:2397:4::2       0    100    0 10001 9001 ?
  * i 2222:2397:4::/48 2222:2397:4::2       0    100    0 ?
  *i 2222:2397:4::/48 2222:2397:4::1       0    100    0 ?
  *i 2222:2397:5::/48 2222:2397:4::2       0    100    0 10001 ?

% NOTE: This command is deprecated. Please use 'show bgp ipv6 unicast'
B2-R3#
```

Figura 13-Tier 2 B preferências rotas BGP

```
B2-R3#sh ipv6 route
IPv6 Routing Table - default - 16 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, I - LISP
B 2222:2397:1::/48 [200/0]
  via 2222:2397:4::1
B 2222:2397:2::/48 [200/0]
  via 2222:2397:4::1
B 2222:2397:3::/48 [200/0]
  via 2222:2397:4::2
B 2222:2397:4::/48 [200/0]
  via 2222:2397:4::1
R 2222:2397:4::1/128 [120/2]
  via FE80::9002:1, FastEthernet0/1
R 2222:2397:4::2/128 [120/2]
  via FE80::9002:2, FastEthernet1/0
LC 2222:2397:4::3/128 [0/0]
  via Loopback0, receive
R 2222:2397:4::1::/64 [120/2]
  via FE80::9002:1, FastEthernet0/1
  via FE80::9002:2, FastEthernet1/0
C 2222:2397:4::2::/64 [0/0]
  via FastEthernet0/1, directly connected
L 2222:2397:4::2::/128 [0/0]
  via FastEthernet0/1, receive
C 2222:2397:4::3::/64 [0/0]
  via FastEthernet1/0, directly connected
L 2222:2397:4::3::/128 [0/0]
  via FastEthernet1/0, receive
C 2222:2397:4::7::/64 [0/0]
  via FastEthernet0/0, directly connected
L 2222:2397:4::7::/128 [0/0]
  via FastEthernet0/0, receive
B 2222:2397:5::/48 [200/0]
  via 2222:2397:4::2
L FE80::/8 [0/0]
  via Null0, receive
B2-R3#
```

```
B2-R3#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, I - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

12.0.0.0/16 is subnetted, 1 subnets
B 12.0.0.0 [200/0] via 15.0.0.1, 00:27:01
13.0.0.0/16 is subnetted, 1 subnets
B 13.0.0.0 [200/0] via 15.0.0.1, 00:28:07
14.0.0.0/16 is subnetted, 1 subnets
B 14.0.0.0 [200/0] via 15.0.0.2, 00:28:07
15.0.0.0/8 is variably subnetted, 14 subnets, 4 masks
R 15.0.0.0/16 [120/1] via 15.0.1.9, 00:01:03, FastEthernet1/0
  [120/1] via 15.0.1.5, 00:00:05, FastEthernet0/1
R 15.0.0.1/32 [120/1] via 15.0.1.5, 00:00:05, FastEthernet0/1
R 15.0.0.2/32 [120/1] via 15.0.1.9, 00:01:04, FastEthernet1/0
C 15.0.0.3/32 is directly connected, Loopback0
R 15.0.1.0/30 [120/1] via 15.0.1.9, 00:01:04, FastEthernet1/0
  [120/1] via 15.0.1.5, 00:00:05, FastEthernet0/1
C 15.0.1.4/30 is directly connected, FastEthernet0/1
L 15.0.1.6/32 is directly connected, FastEthernet0/1
C 15.0.1.8/30 is directly connected, FastEthernet1/0
L 15.0.1.10/32 is directly connected, FastEthernet1/0
R 15.0.1.12/30 [120/1] via 15.0.1.9, 00:01:04, FastEthernet1/0
R 15.0.1.16/30 [120/1] via 15.0.1.9, 00:01:04, FastEthernet1/0
R 15.0.1.20/30 [120/1] via 15.0.1.9, 00:01:04, FastEthernet1/0
C 15.0.2.0/24 is directly connected, FastEthernet0/0
L 15.0.2.1/32 is directly connected, FastEthernet0/0
16.0.0.0/16 is subnetted, 1 subnets
B 16.0.0.0 [200/0] via 15.0.0.2, 00:28:08
B2-R3#
```

Figura 14- Rotas

```

tc@box:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 16436 qdisc noqueue state UNKNOWN
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        inet6 ::1/128 scope host
            valid_lft forever preferred_lft forever
2: dummy0: <BROADCAST,NOARP> mtu 1500 qdisc noop state DOWN
    link/ether 96:ff:57:56:3e:41 brd ff:ff:ff:ff:ff:ff
3: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP qlen 1000
    link/ether 0c:b4:71:97:00:00 brd ff:ff:ff:ff:ff:ff
    inet 15.0.2.2/24 scope global eth0
        inet6 2222:2397:4:7::2/128 scope global
            valid_lft forever preferred_lft forever
        inet6 2222:2397:4:7:eb4:71ff:fe97:0/64 scope global dynamic
            valid_lft 2591870sec preferred_lft 604670sec
        inet6 fe80::9002:7/64 scope link
            valid_lft forever preferred_lft forever
        inet6 fe80::eb4:71ff:fe97:0/64 scope link
            valid_lft forever preferred_lft forever
tc@box:~$ ping 12.0.0.1
PING 12.0.0.1 (12.0.0.1): 56 data bytes
^[[A64 bytes from 12.0.0.1: seq=0 ttl=250 time=194.967 ms
^C
--- 12.0.0.1 ping statistics ---
1 packets transmitted, 1 packets received, 0% packet loss
round-trip min/avg/max = 194.967/194.967/194.967 ms
tc@box:~$ ping 2222:2397:2::2
PING 2222:2397:2::2 (2222:2397:2::2): 56 data bytes
64 bytes from 2222:2397:2::2: seq=0 ttl=61 time=60.734 ms
64 bytes from 2222:2397:2::2: seq=1 ttl=61 time=74.230 ms
^C
--- 2222:2397:2::2 ping statistics ---
3 packets transmitted, 2 packets received, 33% packet loss
round-trip min/avg/max = 60.734/67.482/74.230 ms
tc@box:~$ ping 2222:2397:3::2
PING 2222:2397:3::2 (2222:2397:3::2): 56 data bytes
64 bytes from 2222:2397:3::2: seq=0 ttl=60 time=147.734 ms
^C
--- 2222:2397:3::2 ping statistics ---
1 packets transmitted, 1 packets received, 0% packet loss
round-trip min/avg/max = 147.734/147.734/147.734 ms
tc@box:~$ ping 2222:2397:4::3
PING 2222:2397:4::3 (2222:2397:4::3): 56 data bytes
64 bytes from 2222:2397:4::3: seq=0 ttl=64 time=24.565 ms
^C
--- 2222:2397:4::3 ping statistics ---
1 packets transmitted, 1 packets received, 0% packet loss
round-trip min/avg/max = 24.565/24.565/24.565 ms
tc@box:~$ ping 2222:2397:5::a
PING 2222:2397:5::a (2222:2397:5::a): 56 data bytes
64 bytes from 2222:2397:5::a: seq=0 ttl=56 time=238.185 ms
64 bytes from 2222:2397:5::a: seq=1 ttl=56 time=182.442 ms
^C
--- 2222:2397:5::a ping statistics ---
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 182.442/210.313/238.185 ms
tc@box:~$

```

*Figura 15- ServerAS900z Pings para diversos Tiers*

- Tier 3 A

```

A3-R10#ping 2222:2397:3::1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2222:2397:3::1, timeout is 2 seconds:
!!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 100/132/188 ms
A3-R10#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, H - NHOP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

12.0.0.0/16 is subnetted, 1 subnets
B 12.0.0.0 [200/0] via 16.0.0.7, 00:47:08
13.0.0.0/16 is subnetted, 1 subnets
B 13.0.0.0 [200/0] via 16.0.0.7, 00:47:08
14.0.0.0/16 is subnetted, 1 subnets
B 14.0.0.0 [200/0] via 16.0.0.7, 00:47:08
15.0.0.0/16 is subnetted, 1 subnets
B 15.0.0.0 [200/0] via 16.0.0.7, 00:47:08
16.0.0.0/8 is variably subnetted, 26 subnets, 3 masks
O E2 16.0.0.0/16 [200/0] via 16.0.0.7, 00:47:08
O E2 16.0.0.1/32 [110/3] via 16.0.1.33, 00:46:07, FastEthernet0/0
O E2 16.0.0.2/32 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.0.3/32 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.0.4/32 [110/1] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.0.5/32 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.0.6/32 [110/3] via 16.0.1.33, 00:48:02, FastEthernet0/0
O IA 16.0.0.7/32 [110/4] via 16.0.1.33, 00:48:08, FastEthernet0/0
O IA 16.0.0.8/32 [110/3] via 16.0.1.33, 00:48:39, FastEthernet0/0
O IA 16.0.0.9/32 [110/2] via 16.0.1.33, 00:48:39, FastEthernet0/0
O C 16.0.0.10/32 is directly connected, Loopback0
O E2 16.0.0.11/32 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.0.12/32 [110/3] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.0.13/30 [110/3] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.1.4/30 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.1.8/30 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.1.12/30 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.1.16/30 [110/4] via 16.0.1.33, 00:48:02, FastEthernet0/0
O IA 16.0.1.20/30 [110/3] via 16.0.1.33, 00:48:08, FastEthernet0/0
O IA 16.0.1.24/30 [110/3] via 16.0.1.33, 00:48:39, FastEthernet0/0
O IA 16.0.1.28/30 [110/2] via 16.0.1.33, 00:48:39, FastEthernet0/0
O C 16.0.1.32/30 is directly connected, FastEthernet0/0
L 16.0.1.34/32 is directly connected, FastEthernet0/0
O E2 16.0.1.36/30 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.1.40/30 [110/3] via 16.0.1.33, 00:48:02, FastEthernet0/0
O E2 16.0.1.44/30 [110/2] via 16.0.1.33, 00:48:02, FastEthernet0/0

```

```

[3]-R00ack [ipv6 route
IPv6 Routing Table - default - 31 entries
Codes: C - Connected, I - Incomplete, S - Static, U - Per-user Static route
  O - OSPF, H - Home Agent, R - Mobile Router, R - RIP
  H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
  IS - ISIS summary, O - OSPF, EX - OSPF external, RW - NED
  ND - ND Default, NDn - ND Prefix, DEX - Destination, MDR - Redirect
  O - OSPF Intra, OI - OSPF Intra, OEI - OSPF ext 1, OEO - OSPF ext 2
  ONI - OSPF NSSA ext 1, ONO - OSPF NSSA ext 2, 1 - LISP
M 2222:2397:5::/48 [200/0]
B 2222:2397:5::/7
B 2222:2397:2::/48 [200/0]
  via 2222:2397:5::/7
B 2222:2397:3::/48 [200/0]
  via 2222:2397:5::/7
B 2222:2397:4::/48 [200/0]
  via 2222:2397:5::/7
B 2222:2397:5::/48 [200/0]
  via 2222:2397:5::/7
OI 2222:2397:5::1/128 [110/6]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::2/128 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::3/128 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::4/128 [110/4]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::5/128 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::6/128 [110/6]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::7/128 [110/3]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::8/128 [110/2]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::9/128 [110/1]
  via FE80::1:1:9, FastEthernet0/0
LC 2222:2397:5::A/128 [0/0]
  via Loopback0, receive
OI 2222:2397:5::B/128 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::C/128 [110/6]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::D/128 [110/6]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::E/64 [110/6]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::F/64 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::1::/64 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::2::/64 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::3::/64 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::4::/64 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::5::/64 [110/6]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::6::/64 [110/4]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::7::/64 [110/3]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::8::/128 [110/3]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::8::/64 [110/2]
  via FE80::1:1:9, FastEthernet0/0
C 2222:2397:5::9::/64 [0/0]
  via FastEthernet0/0, directly connected
M 2222:2397:5::9::2/128 [0/0]
  via FastEthernet0/0, receive
OI 2222:2397:5::A::/64 [110/5]
  via FE80::1:1:9, FastEthernet0/0
OI 2222:2397:5::B::/64 [110/6]
  via FE80::1:1:9, FastEthernet0/0
L FF00::/8 [0/0]
  via Null0, receive

```

Figura 16- A3R10 Virtual link, IGP e BGP



```

+ : replicated route, W : next hop override
Gateway of last resort is not set

12.0.0.0/16 is subnetted, 1 subnets
B   12.0.0.0 [200/0] via 16.0.0.3, 00:07:52
13.0.0.0/16 is subnetted, 1 subnets
B   13.0.0.0 [200/0] via 16.0.0.3, 00:07:52
14.0.0.0/16 is subnetted, 1 subnets
B   14.0.0.0 [200/0] via 16.0.0.3, 00:07:52
15.0.0.0/16 is subnetted, 1 subnets
B   15.0.0.0 [200/0] via 16.0.0.3, 00:07:52
16.0.0.0/8 is variably subnetted, 31 subnets, 3 masks
B   16.0.0.0/16 [200/0] via 16.0.0.3, 00:07:52
D IA 16.0.0.1/32 [110/2] via 16.0.1.5, 00:09:01, FastEthernet0/0
D   16.0.0.2/32 [110/1] via 16.0.1.5, 00:09:01, FastEthernet0/0
D   16.0.0.3/32 [110/1] via 16.0.1.9, 00:09:01, FastEthernet0/1
C   16.0.0.4/32 is directly connected, Loopback0
D   16.0.0.5/32 [110/1] via 16.0.1.14, 00:09:01, FastEthernet2/0
D IA 16.0.0.6/32 [110/2] via 16.0.1.14, 00:09:01, FastEthernet2/0
D   16.0.0.7/32 [110/1] via 16.0.1.22, 00:09:01, FastEthernet1/1
D IA 16.0.0.8/32 [110/2] via 16.0.1.22, 00:09:00, FastEthernet1/1
D IA 16.0.0.9/32 [110/3] via 16.0.1.22, 00:08:49, FastEthernet1/1
D E2 16.0.0.10/32 [110/20] via 16.0.1.22, 00:08:54, FastEthernet1/1
D   16.0.0.11/32 [110/1] via 16.0.1.30, 00:09:01, FastEthernet1/0
D IA 16.0.0.12/32 [110/2] via 16.0.1.30, 00:09:01, FastEthernet1/0
D IA 16.0.1.0/30 [110/2] via 16.0.1.5, 00:09:01, FastEthernet0/0
C   16.0.1.4/30 is directly connected, FastEthernet0/0
L   16.0.1.6/32 is directly connected, FastEthernet0/0
C   16.0.1.8/30 is directly connected, FastEthernet0/1
L   16.0.1.10/32 is directly connected, FastEthernet0/1
C   16.0.1.12/30 is directly connected, FastEthernet2/0
L   16.0.1.13/32 is directly connected, FastEthernet2/0
D IA 16.0.1.16/30 [110/2] via 16.0.1.14, 00:09:01, FastEthernet2/0
C   16.0.1.20/30 is directly connected, FastEthernet1/1
L   16.0.1.21/32 is directly connected, FastEthernet1/1
D IA 16.0.1.24/30 [110/2] via 16.0.1.22, 00:09:01, FastEthernet1/1
D IA 16.0.1.28/30 [110/3] via 16.0.1.22, 00:09:00, FastEthernet1/1
D E2 16.0.1.32/30 [110/20] via 16.0.1.22, 00:08:54, FastEthernet1/1
C   16.0.1.30/30 is directly connected, FastEthernet1/0
L   16.0.1.37/32 is directly connected, FastEthernet1/0
D IA 16.0.1.40/30 [110/2] via 16.0.1.30, 00:09:01, FastEthernet1/0
C   16.0.1.44/30 is directly connected, FastEthernet3/0
L   16.0.1.46/32 is directly connected, FastEthernet3/0
A3-R4#traceroute 12.0.0.1
Type escape sequence to abort.
Tracing the route to 12.0.0.1
VRF info: (vrf in name/id, vrf out name/id)
 1 16.0.1.9 20 msec 28 msec 24 msec
 2 15.0.1.17 [AS 9002] 56 msec 24 msec 48 msec
 3 15.0.1.1 [AS 9002] 72 msec 100 msec 96 msec
 4 13.0.1.17 [AS 6001] 132 msec 72 msec 124 msec
 5 13.0.1.9 [AS 6001] 124 msec 132 msec 228 msec
 6 13.0.1.1 [AS 6001] 140 msec 192 msec 172 msec
 7 12.0.1.25 [AS 6000] 140 msec 156 msec 208 msec
 8 12.0.1.5 [AS 6000] 156 msec 92 msec 188 msec
 9 12.0.1.1 [AS 6000] 160 msec 144 msec 168 msec
A3-R4#

```

Figura 17 - A3R4 rotas e direção

```

A3-R7#sh mpls forwarding-table
Local  Outgoing  Prefix      Bytes Label  Outgoing  Next Hop
Label  Label      or Tunnel Id  Switched     interface
7000   Pop Label  16.0.1.28/30  0            Fa0/0      16.0.1.26
7001   Pop Label  16.0.0.8/32   0            Fa0/0      16.0.1.26
7002   Pop Label  16.0.1.4/30   0            Fa0/1      16.0.1.21
7003   Pop Label  16.0.1.8/30   0            Fa0/1      16.0.1.21
7004   Pop Label  16.0.1.12/30  0            Fa0/1      16.0.1.21
7005   Pop Label  16.0.1.36/30  0            Fa0/1      16.0.1.21
7006   4003       16.0.0.11/32  0            Fa0/1      16.0.1.21
7007   4004       16.0.0.5/32   0            Fa0/1      16.0.1.21
7008   Pop Label  16.0.1.44/30  0            Fa0/1      16.0.1.21
7009   Pop Label  16.0.0.4/32   0            Fa0/1      16.0.1.21
7010   4000       16.0.0.3/32   0            Fa0/1      16.0.1.21
7011   4001       16.0.0.2/32   0            Fa0/1      16.0.1.21
7012   4009       16.0.0.12/32  0            Fa0/1      16.0.1.21
7013   4005       16.0.1.40/30  0            Fa0/1      16.0.1.21
7014   4006       16.0.1.16/30  0            Fa0/1      16.0.1.21
7015   4007       16.0.0.1/32   0            Fa0/1      16.0.1.21
7016   4002       16.0.1.0/30   0            Fa0/1      16.0.1.21
7017   8017       16.0.0.9/32   0            Fa0/0      16.0.1.26
7018   Pop Label  16.16.16.2/32[V] 0            aggregate/A
7019   No Label  172.16.0.2/32[V] 0            Fa1/0      192.168.0.6
Local  Outgoing  Prefix      Bytes Label  Outgoing  Next Hop
Label  Label      or Tunnel Id  Switched     interface
7020   No Label  172.16.3.0/24[V] 0            Fa1/0      192.168.0.6
7021   No Label  192.168.0.4/30[V] \
                                           0            aggregate/A
7022   4014       16.0.0.6/32   0            Fa0/1      16.0.1.21
7023   8018       16.0.0.10/32  0            Fa0/0      16.0.1.26
7024   8019       16.0.1.32/30  0            Fa0/0      16.0.1.26
A3-R7#

```

Figura 18- MPLS