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## 1. Introdução

Este relatório descreve a configuração de uma topologia de rede no GNS3, incluindo a implementação de dois routers, dois PCs(em uma fase inicial para testes) e duas máquinas virtuais (VMs), conectados em redes separadas com roteamento estático para garantir a comunicação entre todos os dispositivos. Foram realizados testes de conectividade para validar a configuração.

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## 2. Topologia da Rede

A topologia implementada consiste em:

- **Router 1 (R1)** conectado ao **Router 2 (R2)** via a rede **192.168.1.0/24**.
  - **PC1** conectado ao **R1** na rede **192.168.2.0/24**.
  - **PC2** conectado ao **R2** na rede **192.168.3.0/24**.
  - **VM1** substituiu o PC1, mantendo a mesma rede **192.168.2.0/24**.
  - **VM2** substituiu o PC2, mantendo a mesma rede **192.168.3.0/24**.
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## 3. Configurações Realizadas

### 3.1 Configuração dos Routers

Router 1 (R1)

- Configuração do serial link entre R1 e R2 e o seu teste

```
R1(config)#int s2/0
R1(config-if)#ip add 192.168.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#
*Mar 14 10:25:55.027: %LINK-3-UPDOWN: Interface Serial2/0, changed state to up
R1(config-if)#
*Mar 14 10:25:56.035: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up
R1(config-if)#
R1(config-if)#
R1(config-if)#
*Mar 14 10:26:17.351: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to down
R1(config-if)#
*Mar 14 10:26:47.347: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up
R1(config-if)#do ping 192.168.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/59/68 ms
R1(config-if)#
```

- Configuração da interface que liga o R1 ao PC1

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 24/28/32 ms
R1(config-if)#int f0/0
R1(config-if)#ip add 192.168.2.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#
*Mar 13 13:52:23.655: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 13 13:52:24.655: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```

- Configuração da rota estática no R1

```
R1(config)#
R1(config)#ip route 192.168.3.0 255.255.255.0 192.168.1.2
R1(config)#
```

```
R1(config)#do show 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

    192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, Serial2/0
L       192.168.1.1/32 is directly connected, Serial2/0
    192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, FastEthernet0/0
L       192.168.2.1/32 is directly connected, FastEthernet0/0
S       192.168.3.0/24 [1/0] via 192.168.1.2
R1(config)#
```

- Configuração completa do R1

```
R1(config)#do show ip int brief
Interface                IP-Address      OK? Method Status      Protocol
FastEthernet0/0          192.168.2.1     YES manual up          up
FastEthernet0/1          unassigned      YES unset   administratively down down
FastEthernet1/0          unassigned      YES unset   administratively down down
FastEthernet1/1          unassigned      YES unset   administratively down down
Serial2/0                192.168.1.1     YES manual up          up
Serial2/1                unassigned      YES unset   administratively down down
Serial2/2                unassigned      YES unset   administratively down down
Serial2/3                unassigned      YES unset   administratively down down
R1(config)#
```

## Router 2 (R2)

- Configuração do serial link entre R2 e R1 e o seu teste

```
R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#int s2/0
R2(config-if)#ip add 192.168.1.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#
*Mar 14 10:26:35.043: %LINK-3-UPDOWN: Interface Serial2/0, changed state to up
R2(config-if)#
*Mar 14 10:26:36.047: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up
R2(config-if)#ping 192.168.1.2
^
% Invalid input detected at '^' marker.

R2(config-if)#do ping 192.168.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/62/72 ms
R2(config-if)#
```

- Configuração da interface que liga o R2 ao PC2

```
R2(config-if)#int f0/0
R2(config-if)#ip add 192.168.3.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#
*Mar 13 13:52:42.167: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 13 13:52:43.167: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
R2(config-if)#
```

- Configuração da rota estática no R2

```
R2(config-if)#ip route 192.168.2.0 255.255.255.0 192.168.1.1
R2(config)#
```

```

R2(config)#do show 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

    192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, Serial2/0
L       192.168.1.2/32 is directly connected, Serial2/0
S       192.168.2.0/24 [1/0] via 192.168.1.1
    192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.3.0/24 is directly connected, FastEthernet0/0
L       192.168.3.1/32 is directly connected, FastEthernet0/0
R2(config)#

```

- Configuração completa do R2

```

R2(config)#do show ip int brief
Interface      IP-Address      OK? Method Status      Protocol
FastEthernet0/0 192.168.3.1     YES manual up          up
FastEthernet0/1 unassigned      YES unset   administratively down down
FastEthernet1/0 unassigned      YES unset   administratively down down
FastEthernet1/1 unassigned      YES unset   administratively down down
Serial2/0        192.168.1.2     YES manual up          up
Serial2/1        unassigned      YES unset   administratively down down
Serial2/2        unassigned      YES unset   administratively down down
Serial2/3        unassigned      YES unset   administratively down down
R2(config)#

```

## 3.2 Configuração dos PCS

### PC1

- Configuração do IP e do Default Gateway (neste caso vai ser o IP do R1 que está conectado à respectiva interface).

```

PC1> ip 192.168.2.10 255.255.255.0 192.168.2.1
Checking for duplicate address...
PC1 : 192.168.2.10 255.255.255.0 gateway 192.168.2.1

PC1> show ip

NAME           : PC1[1]
IP/MASK        : 192.168.2.10/24
GATEWAY        : 192.168.2.1
DNS            :
MAC            : 00:50:79:66:68:00
LPORT         : 10014
RHOST:PORT     : 127.0.0.1:10015
MTU            : 1500

```

### PC2

- Configuração do IP e do Default Gateway (neste caso vai ser o IP do R2 que está conectado à respetiva interface).

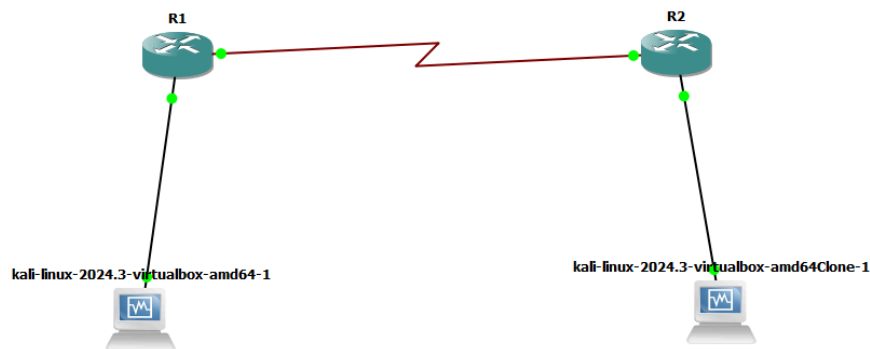
```
PC2> ip 192.168.3.10 255.255.255.0 192.168.3.1
Checking for duplicate address...
PC1 : 192.168.3.10 255.255.255.0 gateway 192.168.3.1

PC2> show ip0
Invalid arguments

PC2> show ip

NAME       : PC2[1]
IP/MASK     : 192.168.3.10/24
GATEWAY     : 192.168.3.1
DNS        :
MAC        : 00:50:79:66:68:01
LPORT      : 10016
RHOST:PORT : 127.0.0.1:10017
MTU        : 1500
```

## Layout completo da rede



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## 4. Testes de Conectividade

### 4.1 Testes Individuais (PC's para os seus Routers)

- Teste de conectividade do PC1 -> R1

```
PC1> ping 192.168.2.1
192.168.2.1 icmp_seq=1 timeout
84 bytes from 192.168.2.1 icmp_seq=2 ttl=255 time=15.165 ms
84 bytes from 192.168.2.1 icmp_seq=3 ttl=255 time=16.139 ms
84 bytes from 192.168.2.1 icmp_seq=4 ttl=255 time=15.113 ms
84 bytes from 192.168.2.1 icmp_seq=5 ttl=255 time=15.140 ms
```

- Teste de conectividade do PC2 > R2

```
PC2> ping 192.168.3.1
84 bytes from 192.168.3.1 icmp_seq=1 ttl=255 time=15.719 ms
84 bytes from 192.168.3.1 icmp_seq=2 ttl=255 time=15.652 ms
84 bytes from 192.168.3.1 icmp_seq=3 ttl=255 time=15.340 ms
84 bytes from 192.168.3.1 icmp_seq=4 ttl=255 time=15.629 ms
84 bytes from 192.168.3.1 icmp_seq=5 ttl=255 time=15.643 ms
```

- Teste de conectividade do PC1 -> PC2

```
PC1> ping 192.168.3.10
84 bytes from 192.168.3.10 icmp_seq=1 ttl=62 time=60.743 ms
84 bytes from 192.168.3.10 icmp_seq=2 ttl=62 time=60.506 ms
84 bytes from 192.168.3.10 icmp_seq=3 ttl=62 time=60.628 ms
84 bytes from 192.168.3.10 icmp_seq=4 ttl=62 time=60.225 ms
84 bytes from 192.168.3.10 icmp_seq=5 ttl=62 time=60.224 ms
```

- Teste de conectividade do PC2 -> PC1

```
PC2> ping 192.168.2.10
84 bytes from 192.168.2.10 icmp_seq=1 ttl=62 time=60.018 ms
84 bytes from 192.168.2.10 icmp_seq=2 ttl=62 time=60.296 ms
84 bytes from 192.168.2.10 icmp_seq=3 ttl=62 time=60.268 ms
84 bytes from 192.168.2.10 icmp_seq=4 ttl=62 time=60.814 ms
84 bytes from 192.168.2.10 icmp_seq=5 ttl=62 time=60.871 ms
```

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## 5. Adição de duas máquinas virtuais

Como foi pedido no enunciado, adicionei então duas máquinas virtuais, substituindo então pelo PC1 e PC2 respetivamente.

As seguintes configurações foram realizadas em cada uma das máquinas virtuais:

### VM1

- Atribuição do IP à VM1 e a respetiva rota por defeito para o R1.

```

(kali@kali)-[~]
$ sudo ip addr add 192.168.2.20/24 dev eth0

(kali@kali)-[~]
$ sudo ip route add default via 192.168.2.1

(kali@kali)-[~]
$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host noprefixroute
        valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:ad:25:87 brd ff:ff:ff:ff:ff:ff
    inet 192.168.2.20/24 scope global eth0
        valid_lft forever preferred_lft forever
3: docker0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state DOWN group default
    link/ether 02:42:07:2f:56:9f brd ff:ff:ff:ff:ff:ff
    inet 172.17.0.1/16 brd 172.17.255.255 scope global docker0
        valid_lft forever preferred_lft forever

```

## VM2

- Atribuição do IP à VM2 e a respetiva rota por defeito para o R2.

```

(kali@kali)-[~]
$ sudo ip addr add 192.168.3.20/24 dev eth0

(kali@kali)-[~]
$ sudo ip route add default via 192.168.3.1

(kali@kali)-[~]
$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host noprefixroute
        valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:ad:25:87 brd ff:ff:ff:ff:ff:ff
    inet 192.168.3.20/24 scope global eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::f735:2727:42a5:27c/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: docker0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state DOWN group default
    link/ether 02:42:46:03:97:ff brd ff:ff:ff:ff:ff:ff
    inet 172.17.0.1/16 brd 172.17.255.255 scope global docker0
        valid_lft forever preferred_lft forever

```

Como os routers já se encontravam com as configurações certas dos testes anteriormente feitos, não houve necessidade de fazer configurações adicionais dos mesmos.

## 6. Testes de Conectividade nas VM's

### 6.1 Testes Individuais (VM's para os seus Routers e entre VM's)

- Teste conectividade VM1 -> R1

```

(kali㉿kali)-[~]
$ ping 192.168.2.1
PING 192.168.2.1 (192.168.2.1) 56(84) bytes of data.
64 bytes from 192.168.2.1: icmp_seq=1 ttl=255 time=8.27 ms
64 bytes from 192.168.2.1: icmp_seq=2 ttl=255 time=8.49 ms
64 bytes from 192.168.2.1: icmp_seq=3 ttl=255 time=9.52 ms
64 bytes from 192.168.2.1: icmp_seq=4 ttl=255 time=10.5 ms
64 bytes from 192.168.2.1: icmp_seq=5 ttl=255 time=10.5 ms
^C
— 192.168.2.1 ping statistics —
5 packets transmitted, 5 received, 0% packet loss, time 4008ms
rtt min/avg/max/mdev = 8.270/9.445/10.490/0.937 ms

```

- Teste conectividade VM2 -> R2

```

(kali㉿kali)-[~]
$ ping 192.168.3.1
PING 192.168.3.1 (192.168.3.1) 56(84) bytes of data.
64 bytes from 192.168.3.1: icmp_seq=1 ttl=255 time=6.18 ms
64 bytes from 192.168.3.1: icmp_seq=2 ttl=255 time=3.04 ms
64 bytes from 192.168.3.1: icmp_seq=3 ttl=255 time=1.69 ms
^C
— 192.168.3.1 ping statistics —
3 packets transmitted, 3 received, 0% packet loss, time 2144ms
rtt min/avg/max/mdev = 1.694/3.637/6.178/1.878 ms

```

- Teste conectividade VM1 -> VM2

```

(kali㉿kali)-[~]
$ ping 192.168.3.20
PING 192.168.3.20 (192.168.3.20) 56(84) bytes of data.
64 bytes from 192.168.3.20: icmp_seq=1 ttl=62 time=40.5 ms
64 bytes from 192.168.3.20: icmp_seq=2 ttl=62 time=41.3 ms
64 bytes from 192.168.3.20: icmp_seq=3 ttl=62 time=32.7 ms
64 bytes from 192.168.3.20: icmp_seq=4 ttl=62 time=33.7 ms
64 bytes from 192.168.3.20: icmp_seq=5 ttl=62 time=34.7 ms
^C
— 192.168.3.20 ping statistics —
5 packets transmitted, 5 received, 0% packet loss, time 4006ms
rtt min/avg/max/mdev = 32.740/36.594/41.311/3.585 ms

```

- Teste conectividade VM2 -> VM1



```
(kali㉿kali)-[~]  
$ ping 192.168.2.20  
PING 192.168.2.20 (192.168.2.20) 56(84) bytes of data.  
64 bytes from 192.168.2.20: icmp_seq=1 ttl=62 time=38.0 ms  
64 bytes from 192.168.2.20: icmp_seq=2 ttl=62 time=40.7 ms  
64 bytes from 192.168.2.20: icmp_seq=3 ttl=62 time=34.0 ms  
64 bytes from 192.168.2.20: icmp_seq=4 ttl=62 time=33.6 ms  
64 bytes from 192.168.2.20: icmp_seq=5 ttl=62 time=41.7 ms  
64 bytes from 192.168.2.20: icmp_seq=6 ttl=62 time=34.9 ms  
^C  
— 192.168.2.20 ping statistics —  
6 packets transmitted, 6 received, 0% packet loss, time 5089ms  
rtt min/avg/max/mdev = 33.551/37.145/41.689/3.208 ms
```

Com os testes realizados podemos concluir que as VM's conseguem comunicar entre si através dos routers, confirmando que as rotas estáticas foram configuradas corretamente.

---

## 7. Conclusão

A configuração realizada permitiu a comunicação entre duas redes distintas através de dois routers interligados. Os testes confirmam que tanto os PCs quanto as máquinas virtuais foram corretamente integrados à rede, permitindo uma comunicação eficiente entre os dispositivos. A implementação das rotas estáticas garantiu o encaminhamento correto dos pacotes entre as sub-redes, validando o funcionamento da topologia configurada.

Os prints anexados ao relatório demonstram as configurações aplicadas e os resultados obtidos nos testes de conectividade. A solução implementada cumpre os requisitos do projeto e pode ser expandida conforme necessário.