DEPARTAMENTO DE ELETRÓNICA, TELECOMUNICAÇÕES
E INFORMÁTICA

LICENCIATURA EM ENGENHARIA DE COMPUTADORES E INFORMÁTICA

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REDES DE COMUNICAÇÕES II

LABORATORY GUIDE NO. 2:

INTERIOR GATEWAY IP ROUTING

In this Laboratory Guide:

- all routers should use the IOS image 15.1(4) of routers 7200 (provided in the elearning page of RC II) and with two network adapters:
  - C7200-IO-2FE in slot 0, providing 2 FastEthernet routing interfaces: `f0/0` and `f0/1`
  - PA-2FE-TX in slot 1, providing 2 FastEthernet routing interfaces: `f1/0` and `f1/1`
- all switches should use the basic Ethernet Switch available in GNS3

1. Initial network setup

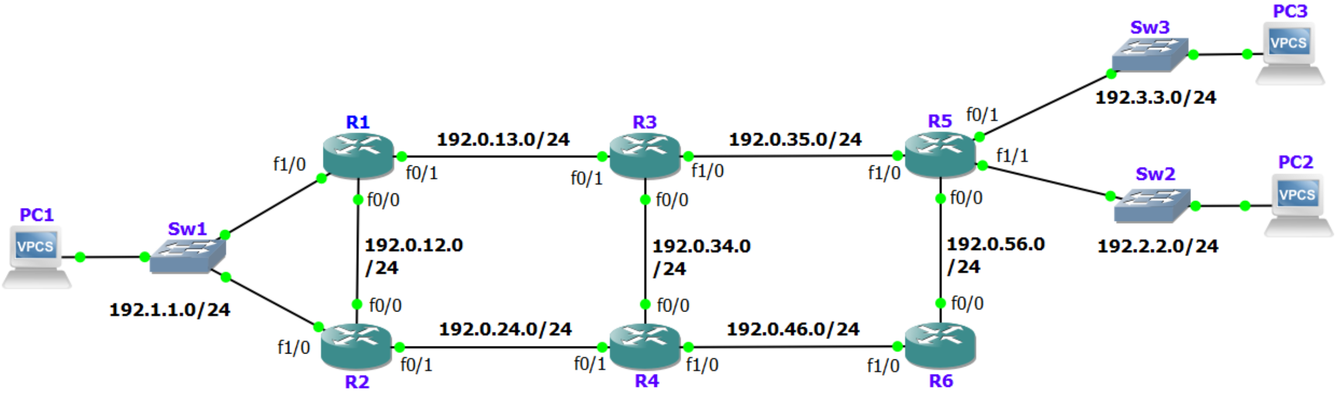
Consider the following network setup composed of 6 routers, seven IP transit networks (one IP network per point-to-point link between routers) and 3 stub networks (one IP network per each switch). Create a GNS3 template with all equipment and all links. Then, run the template.

On each interface of each router:

- configure an IP address (following the IP network addresses in the figure) with the host part of the address given by the number of the router name (for example, interface `f1/0` of router R3 is configured with the command `ip address 192.0.35.3 255.255.255.0`)
- activate the interface (command `no shutdown`)

Then, on each PC, configure its IP address (following the IP network addresses in the figure) and the IP address of its default gateway in the following way:

- the host part of the IP address is equal to 100 for all PCs (for example, PC1 with 192.1.1.100)
- the default gateway of PC1, PC2 and PC3 is R2, R5 and R5, respectively.



Configuration of IP address and default gateway in PC1:

```
PC1> ip 192.1.1.100/24 192.1.1.2
PC1> save
```

Check the resulting configuration:

```
PC1> show ip
```

Check the IP routing table of each router. Verify that, on each router, its routing table includes all directly connected IP networks and does not include any remote IP network (if not, there are configuration errors that must be identified and corrected).

Check the complete IP routing table in router R1:

```
R1# show ip route
```

Check the IP routing table in router R1 without the Link IP addresses:

```
R1# show ip route | exclude L
```

2. IP routing based on RIP version 2

Activate the RIPv2 routing protocol <u>only in routers R1 and R2</u>. On each router, include all directly connected IP networks in the RIP process.

Activation of RIPv2 in router R1:

```
R1# configure terminal
R1(config)# router rip
R1(config-router)# version 2
R1(config-router)# network 192.1.1.0
R1(config-router)# network 192.0.12.0
R1(config-router)# network 192.0.13.0
R1(config-router)# end
R1# write
```

Check the resulting configuration:

```
R1# show configuration
```

2.a. Analyze the IP routing tables of the routers. Justify the new entries that were added by the RIP protocol in all routers. Is the network 192.1.1.0/24 a transit or a stub network?

Depois de adicionar as networks no protocolo RIP, ambos os routers ficaram a conhecer networks que nao conseguiam acessar diretamente.
Com custo 1 em ambos. A network 192.1.1.0/24 é uma network de transito, pois esta tem um "caminho alternativo" para as conecções.

Start two Wireshark captures: one in link PC1-Sw1 and another in link R1-R2. Wait until you have at least a total of 6 RIPv2 messages on each capture.

O protocolo RIP para cada porta/network que comunica, envia todas as networks que conhece, excepto a network que está a ser usada para enviar o pacote. Isto acontece para todas as portas e este método chama-se SPLIT HORIZON

IMPORTANT NOTE ON MULTICAST FRAMES FORWARDING IN A SWITCH: By default, an Ethernet frame for a multicast address is treated by a Switch in the same way as a frame for the broadcast address: the frame is forwarded by the Switch to all ports, except the incoming port.

Based on the observed RIPv2 messages in the two captures:

2.b. Check that RIP runs over UDP (what are the port numbers?) which runs over IPv4 (what are the origin and destination IP addresses?). O RIP usa UDP para comunicar a partir da porta 520. A origem é o router e o destino é multicast.

2.c. Check the type of observed RIP messages and how periodically they are sent by each router.

Os tipos de mensagens são RIP responses e têm periodicidade de 30 segundos.

2.d. Analyze the distance vector sent in the RIP Response messages by each router on each link (is the protocol configured with or without split-horizon?) (justify each network and associated metric of each announced distance vector). O protocolo está configurado com split horizon por defeito, pois em cada RIP response na qual estava a ser enviado o pacote, nao era partilhado o IP dessa rede.

Configure the interfaces `f1/0` of both routers R1 and R2 as passive-interfaces for the RIP protocol.

Configuration of a passive-interface for RIP in router R1:

```
R1# configure terminal
R1(config)# router rip
R1(config-router)# passive-interface f1/0
R1(config-router)# end
R1# write
```

2.e. Analyze the IP routing tables of the routers. Justify again the entries added by the RIP protocol. Is the network 192.1.1.0/24 a transit or a stub network? Ao colocar a porta F1/0 em passive mode, torna a network 192.1.1.0 como uma network stub

2.f. Again, start two Wireshark captures: one in link PC1-Sw1 and another in link R1-R2. Do you capture any RIPv2 message in link PC1-Sw1? Why? Analyze and justify the distance vector sent in the RIP messages observed in link R1-R2. Não são capturados pacotes RIP na captura PC1-Sw1 devido à ativação do passive mode na porta f1/0. Deixa de haver comunicação do protocolo RIP a partir das portas f1/0 dos routers R1 e R2.

Start a never-ending ping command at PC1 to the address of the interface `f0/0` of router R2 (at PC1, run `ping 19.0.12.2 -t`). Shutdown the interface `f1/0` of router R2 (simulating a link failure).

2.g. Did you lose the connectivity in the ping command? Why?

Sim, perdi a conectividade, pois a interface f1/0 do router R2 é a gateway do PC1. Se eu fechar essa porta, não há nenhum protocolo (VRRP off) para alterar a gateway de forma dinamica.

Stop the previous never-ending ping command (by inserting `Ctrl+C`) and activate the interface `f1/0` of router R2 (i.e., run `no shutdown` on the interface).

Configure the Virtual Router Redundancy Protocol (VRRP) in the interfaces `f1/0` of both routers R1 and R2 to provide a virtual default gateway address 192.1.1.254 to the LAN of Sw1. Do not change the default VRRP priority value of the interfaces. (IMPORTANT: you must also change the default gateway address of PC1 to 192.1.1.254).

Configuration of VRRP in an interface of router R1:

```
R1# configure terminal
R1(config)# interface f1/0
R1(config-if)# vrrp 1 ip 192.1.1.254
R1(config-if)# vrrp 1 priority 120   (to change the default value 100)
R1(config-if)# end
R1# write
```

Start a Wireshark capture in link PC1-Sw1 and do not stop until it is explicitly requested.

2.h. By analyzing the VRRP messages, explain how VRRP works and what is the current master virtual default gateway. ✓

2.i. Shutdown interface `f1/0` of router R2 (simulating a link failure). Analyze the VRRP messages and identify the resulting master virtual default gateway. ✓

2.j. Activate the interface `f1/0` of router R2. Analyze the VRRP messages and identify the resulting master virtual default gateway. ✓

2.k. Stop the Wireshark capture in link PC1-Sw1. Start a never-ending ping command at PC1 to the address of the interface `f0/0` of router R2. Run the following steps:

(a) shutdown the interface `f1/0` of router R2,
(b) wait for 15 seconds,
(c) activate again the interface `f1/0` of router R2.

Stop the never-ending ping command in PC1. What happened to the connectivity of the ping command in step (a) and step (c)? ✓

Activate the RIPv2 routing protocol in all other routers (i.e., R3, R4, R5 and R6). Include all directly connected IP networks in the RIP process of routers R3, R4 and R6. On the other hand, include only the networks 192.0.35.0/24 and 192.0.56.0/25 in the RIP process of router R5.

2.l. Analyze the IP routing tables of all routers. Verify that each router always selects the next-hop neighbor routers providing the minimum cost paths to each known remote IP network. Verify also that the IP networks of Sw2 and Sw3 are only known by router R5 (why?). ✓

2.m. Configure router R5 to announce itself to all other RIP routers as the destination of a default RIP route. Analyze the IP routing tables of all routers. Justify the new entries on the routing tables due to the configuration of the default RIP route. ✓

Configuration of router R5 as the destination of a default RIP route:

```
R5# configure terminal
R5(config)# router rip
R5(config-router)# default-information originate
R5(config-router)# end
R5# write
```

2.n. Check (through ping) that all pairs of PCs have connectivity between them (if not, there are configuration errors that must be identified and corrected).

2.h) O VRRP funciona de forma a que um grupo de routers compartilhe um único endereço IP virtual que serve como o gateway padrão para uma LAN.
Um router no grupo é eleito como o master com base em sua prioridade, enquanto os outros atuam como backups. O master envia periodicamente mensagens de multicast VRRP para informar os backups de que ele ainda está ativo. Se os backups pararem de receber essas mensagens (por exemplo, se o mestre falhar), um deles — com a próxima prioridade mais alta — assumirá como mestre.
O roteador R1 e R2 foi configurado com uma prioridade de 120. Como resultado, R2 é o master (pois o seu IP é maior que o IP de R1) e é aquele que responde às solicitações ARP e manipula o tráfego para o IP virtual compartilhado (192.1.1.254).
Isso garante que, mesmo que o R2 ou sua interface associada falhem, a LAN continuará a usar o mesmo gateway padrão fornecido pelo R1 até que uma alteração seja necessária.

2.i) Ao desligar a interface f1/0 do R2, este deixa de conseguir comunicar com o Sw1. Como resultado disso, R2 deixa de enviar os VRRP Announcements, o router R1 detecta essa falha e toma controlo como master, ou seja, agora todos os pacotes direcionado para 192.1.1.254 passarão no router R1.

2.j) Ao voltar a ativar a porta f1/0 do router R2, este como tem uma prioridade mais alta que R1, volta a tornar-se o master.

2.k) Como a porta f1/0 do router R2 foi desativada, a porta f1/0 do route R1 passou a ser master. Os pings passaram a ser mandados para o router R1 e encaminhados para a porta f0/0 de R2.

2.l) As networks dos switches 2 e 3 só são conhecidas no router R5, pois não foi introduzido no router R5 as networks para o protocolo RIPv2.

2.m) Quando é configurado no router R5 como default-information route, este passa a gerar um anúncio de rota default (0.0.0.0/0) para todos os seus vizinhos RIP. Com isso, todos os routers recebem essa rota através das atualizações RIP e a instalam nas suas route table, apontando para R5 como o next hop para quaisquer destinos que não correspondam a uma rota específica.

Stop running the GNS3 template and save a copy. Then, run again the template and eliminate the RIP protocol in all routers (to use this template in the next task, keeping the configuration of the VRRP). ✓

Elimination of RIP in router R1:

```
R1# configure terminal
R1(config)# no router rip
R1(config)# end
R1# write
```

3. IP routing based on OSPF version 2

(TO BE COMPLETED)