



ADDETC – Área Departamental de Engenharia Eletrónica e Telecomunicações  
e de Computadores

LEIM -Licenciatura Engenharia informática e multimédia

## **Redes de Internet**

### **Trabalho prático 1**

**Turma:**

LEIM-51D

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# 1. Introdução

O primeiro trabalho prático de Redes de Internet tem como objetivo principal aprofundar o conhecimento dos alunos perante as tecnologias de redes de VLANs, protocolo STP, protocolo RSTP, encaminhamento estático e o protocolo RIP.

O funcionamento do trabalho é feito de tal maneira que existem duas empresas distintas, a empresa A e a empresa B. A conexão entre as duas empresas é assegurada através de uma topologia intermédia, fornecida por um ISP e um router de cada empresa.

Dentro de cada empresa existe uma topologia interna para garantir a conectividade entre todos os PCs da mesma empresa, que tem de ser alterada. Para que toda a topologia fique funcional é necessário configurar switches e também routers. Quando concluídas as configurações deve ser possível comunicar a partir da empresa A até á empresa B e vice-versa além de permitir a conexão para a internet.

## 2. Desenvolvimento

### Tarefa 1

- a) O comando é utilizado quando não se precisa de um servidor DNS para o router atribuir endereços IP. O comando “*no ip domain-lookup*” serve para desativar o processo de transação do DNS e assumir apenas aqueles endereços introduzidos pelo administrador.

Figura 1 - Configuração do comando no router

- b) Por omissão qualquer *switch* vem com uma VLAN por omissão que é a VLAN 1.

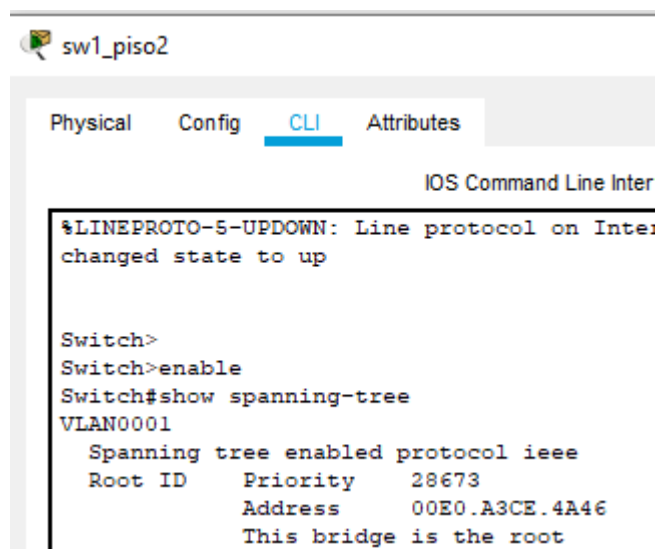
```
Switch#show vlan
```

VLAN	Name	Status	Ports
1	default	active	Fa0/1, Fa0/2, Fa0/3,

Figura 2 - VLAN por omissão

- c) Quando uma trama é recebida com o mesmo ID da VLAN por omissão, a trama é descartada, isto porque a VLAN 1 não possui tag.
- d) Ao reduzir o tempo do “Max Age”, acontece que os endereços aprendidos na FDB (forwarding database) duram metade do tempo, finalizando esse tempo a entrada é descartada. A redução do “Forwarding Delay” provoca que para a formação de topologia a transição para o estado forwarding seja reduzida para metade do tempo.

A root bridge é o Sw1 piso 2 porque diz na topologia.



```
sw1_piso2
Physical Config CLI Attributes
IOS Command Line Inter
%LINEPROTO-5-UPDOWN: Line protocol on Inte
changed state to up

Switch>
Switch>enable
Switch#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    28673
            Address      00E0.A3CE.4A46
            This bridge is the root
```

Figura 3 - Root bridge

- f) Correndo o comando “*show spanning-tree sum*” o modo é o PVST, que segundo o website da Cisco consiste em Per VLAN Spanning-tree. Desta forma existe uma Spanning Tree, por VLAN dentro dos switches.

```
Switch#show spanning-tree sum
Switch is in pvst mode
```

Figura 4 - Configuração de PVST

- g) Como foi dito anteriormente existe uma Spanning-tree por VLAN, como só existe ainda a VLAN por omissão só existe uma Spanning-tree.

h)

Port	PC	RPC	RP	Segmento	DPC	DP	Alt	Back	Comments
Sw1_piso1//Fa0/2	19	19+4=23	-	Sw1_piso1//Fa0/2 - Sw2_piso1//Fa0/2	19	-	-	X	
Sw1_piso1//Fa0/3	19	19	X	Sw1_piso1//Fa0/3 - Sw_DC//Gi0/6	-	-	-	-	
Sw1_piso1//Fa0/10	19	-	-	Sw1_piso1//Fa0/10 - PC5	-	X	-	-	PC5
Sw1_piso1//Fa0/20	19	19+19+19+4 = 61	-	Sw1_piso1//Fa0/20 - Sw2_piso2//Fa0/20	19	X	-	-	
Sw1_piso1//Fa0/23	19	19+4+19 = 42	-	Sw1_piso1//Fa0/23 - Sw1_piso2//Fa0/23	19	X	-	-	
Sw1_piso1//Gi0/1	4	4+4+19 = 27	-	Sw1_piso1//Gi0/1 - Sw2_piso1//Gi0/1	19	X	-	-	
Sw1_piso2//Fa0/2	19	19+19+4 = 42	-	Sw1_piso2//Fa0/2 - Sw2_piso2//Gi0/2	19+4	X	-	-	
Sw1_piso2//Fa0/10	19	-	-	Sw1_piso2//Fa0/10 - PC7	-	X	-	-	PC7
Sw1_piso2//Gi0/1	4	4+19 = 23	X	Sw2_piso1//Gi0/1 - Sw1_piso1//Gi0/1	-	-	-	-	
Sw1_piso2//Fa0/23	19	19+19 = 38	-	Sw1_piso2//Fa0/23 - Sw1_piso1//Fa0/23	19+4	-	-	X	
Sw2_piso1//Fa0/2	19	19+19 = 38	-	Sw2_piso1//Fa0/2 - Sw1_piso1//Fa0/2	4	X	-	-	
Sw2_piso1//Fa0/10	19	-	-	Sw2_piso1//Fa0/10 - PC6	-	X	-	-	PC6
Sw2_piso1//Fa0/24	19	19+19+4 = 42	-	Sw2_piso1//Fa0/24 - Sw2_piso2//Fa0/24	4	X	-	-	
Sw2_piso1//Gi0/1	4	4	X	Sw2_piso1//Gi0/1 - Sw_DC//Gi0/2	-	-	-	-	
Sw2_piso2//Fa0/10	19	-	-	Sw2_piso2//Fa0/10 - PC8	-	X	-	-	PC8
Sw2_piso2//Fa0/11	19	-	-	Sw2_piso2//Fa0/11 - PC9	-	X	-	-	PC9
Sw2_piso2//Fa0/20	19	19+4 = 23	X	Sw2_piso2//Fa0/20 - Sw1_piso1//Fa0/20	-	-	-	-	
Sw2_piso2//Fa0/24	19	19+4 = 23	-	Sw2_piso2//Fa0/24 - Sw2_piso1//Fa0/24	19+4	-	-	X	
Sw2_piso2//Gi0/2	4	19+4+19 = 42	-	Sw2_piso2//Gi0/2 - Sw1_piso2//Fa0/2	19+4	-	X	-	
Sw_DC//Gi0/2	4	-	-	Sw_DC//Gi0/2 - Sw2_piso1//Gi0/1	0	X	-	-	
Sw_DC//Gi0/6	4	-	-	Sw_DC//Gi0/6 - Sw1_piso1//Fa0/3	0	X	-	-	
Sw_DC//Gi0/4	4	-	-	Sw_DC//Gi0/4 - Hub0//F0/1	0	-	X	-	
Sw_DC//Gi0/3	4	-	-	Sw_DC//Gi0/3 - Hub0//F0/1	0	X	-	-	
Hub0//F0/1	19	19	X	Hub0//F0/1 - Sw_DC//Gi0/3	-	-	-	-	
Hub0//F0/1	19	19	-	Hub0//F0/1 - Sw_DC//Gi0/4	19	X	-	-	
Hub0//F0/2	19	-	-	Hub0//F0/2 - Server2	-	X	-	-	Server2

Sim, os resultados correspondem á topologia obtida no simulador.

i) PCA – Sw2\_Piso2 – Sw1\_Piso2 – Sw1\_Piso1 – Sw\_DC – Router A

O custo da ligação é  $19+100+19+19+4 = 161$



j) Sim,  
porta  
Gi0/4

```
Router>
Router>enable
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#no ip domain-lookup
```

possui uma  
alternate  
para o hub.

```
Switch#show spanning-tree
VLAN0001
Spanning tree enabled protocol ieee
Root ID    Priority    24577
           Address      0002.4AE4.E093
           This bridge is the root
```

**Figura 5 - Porta do Switch\_DC**

k) Isto deve-se ao facto de que uma porta para ser *designated* é o caminho do root até um segmento. Como o caminho para um segmento a partir do root é sempre zero todas as suas partam ficam *designated ports*.

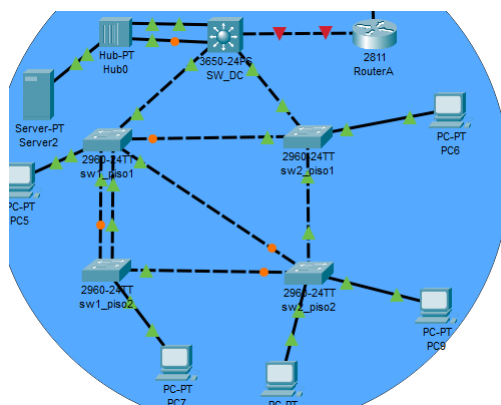
l) Para configurar o switch para Rapid Per VLAN Spanning-Tree é necessário utilizar o comando *spanning-tree mode rapid-pvst* obtendo assim a imagem que se segue. Para configurar todos para o protocolo é necessário configurar todos os equipamentos.

```
Switch#show spanning-tree
VLAN0001
Spanning tree enabled protocol rstp
```

**Figura 6 - Configuração de pvst**

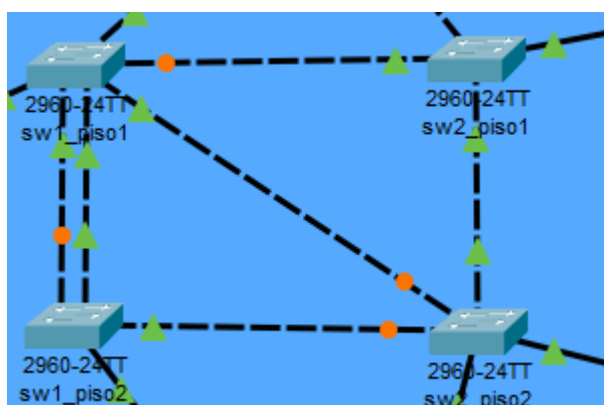
m) Continua a existir somente um STP, pois continua a existir somente uma VLAN que é a 1.

n) Mudando as interfaces de FastEthernet das switches para Giga como o custo é menor passam a ser *designated* e a outra ligação fica bloqueada. De modo a que ambas as ligações ficassem operacionais seria necessário alterar os ramos mais abaixo na árvore de modo a remover os ciclos que surgissem, nomeadamente terminar a ligação entre o Sw2-Piso2 e o Sw1-Piso2.

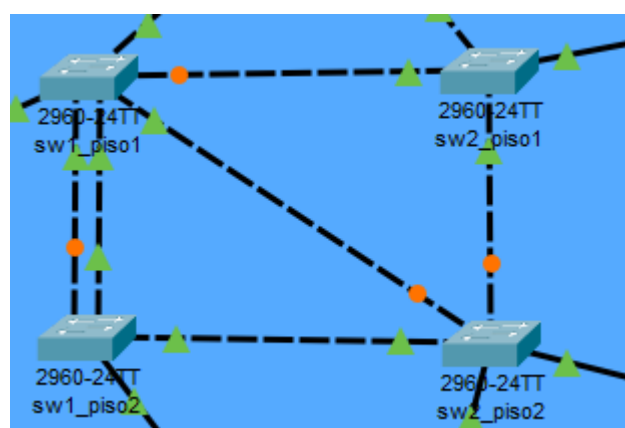


**Figura 7 - Topologia com a segunda ligação ativa**

- o) Por omissão este envia para o caminho com menor custo, mas criando um caminho com menor custo este passa a utilizar o caminho com menor custo criada a partir das interfaces Giga.



**Figura 9 - Configuração por omissão**



**Figura 8 - Configuração alterado**

- p) A afirmação é incorreta, apesar do Hub não incrementar o custo de um caminho, este provoca um atraso relativamente parecido ao switch. Ao adicionar um switch fica um caminho mais confiável já que este incrementa o custo e permite criar uma topologia que se aproxima mais da situação real.

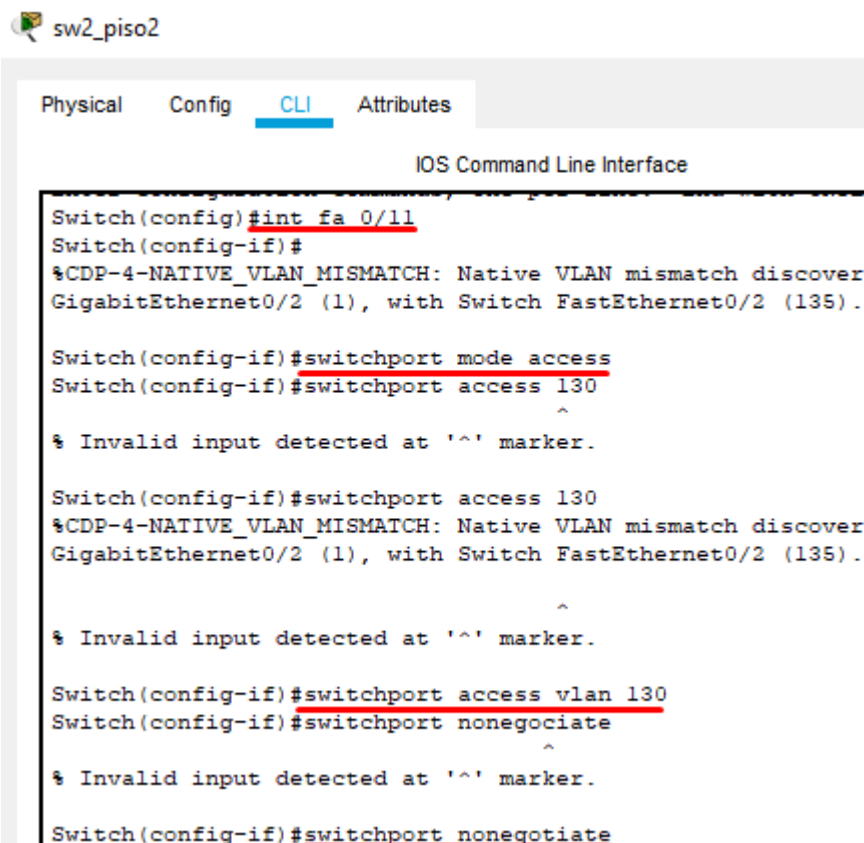
## Tarefa 2

- a) Para segmentar a rede em VLANs, é necessário defini-las em todos os switches participantes na topologia. Os comandos utilizados (em modo configuração) para realizar essa operação foram nomeadamente: ***vlan N***, onde N representa o número da VLAN pretendida e o ***name X***, onde X representa o nome da VLAN. Como se segue no exemplo:

```
S1(config)#vlan 10
S1(config-vlan)#name Faculty/Staff
S1(config-vlan)#vlan 20
S1(config-vlan)#name Students
```

Figura 10 - Implementação das VLANs

- b) Para realizar a topologia pretendida foi utilizada a técnica de ligações entre switches ser sempre *trunk* e entre *switch* e *pc* ser modo *access* com a VLAN pretendida. Estas configurações foram realizadas para todas as interfaces no estado *forwarding*. Para desligar o DTP foi utilizado o comando ***switchport nonegotiate***, prevenindo que portas em modo *trunk* fossem propagadas para as restantes portas.



```

sw2_piso2

Physical  Config  CLI  Attributes

IOS Command Line Interface

Switch(config)#int fa 0/11
Switch(config-if)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered
GigabitEthernet0/2 (1), with Switch FastEthernet0/2 (135).

Switch(config-if)#switchport mode access
Switch(config-if)#switchport access 130
^
% Invalid input detected at '^' marker.

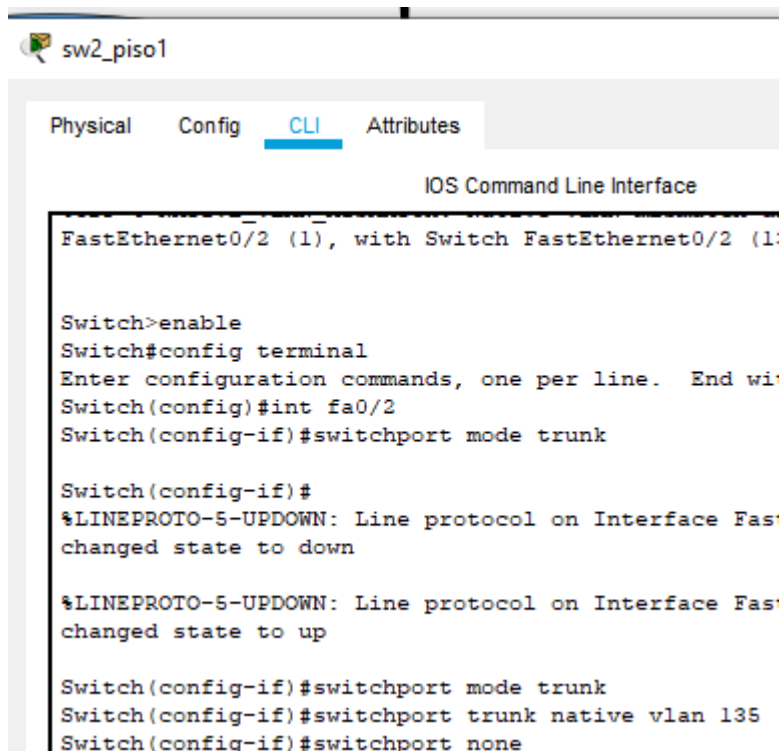
Switch(config-if)#switchport access 130
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered
GigabitEthernet0/2 (1), with Switch FastEthernet0/2 (135).
^
% Invalid input detected at '^' marker.

Switch(config-if)#switchport access vlan 130
Switch(config-if)#switchport nonegotiate
^
% Invalid input detected at '^' marker.

Switch(config-if)#switchport nonegotiate

```

Figura 11 - Configuração da interface mode access



```

sw2_piso1

Physical  Config  CLI  Attributes

IOS Command Line Interface

FastEthernet0/2 (1), with Switch FastEthernet0/2 (135)

Switch>enable
Switch#config terminal
Enter configuration commands, one per line. End with CTRL-Z
Switch(config)#int fa0/2
Switch(config-if)#switchport mode trunk

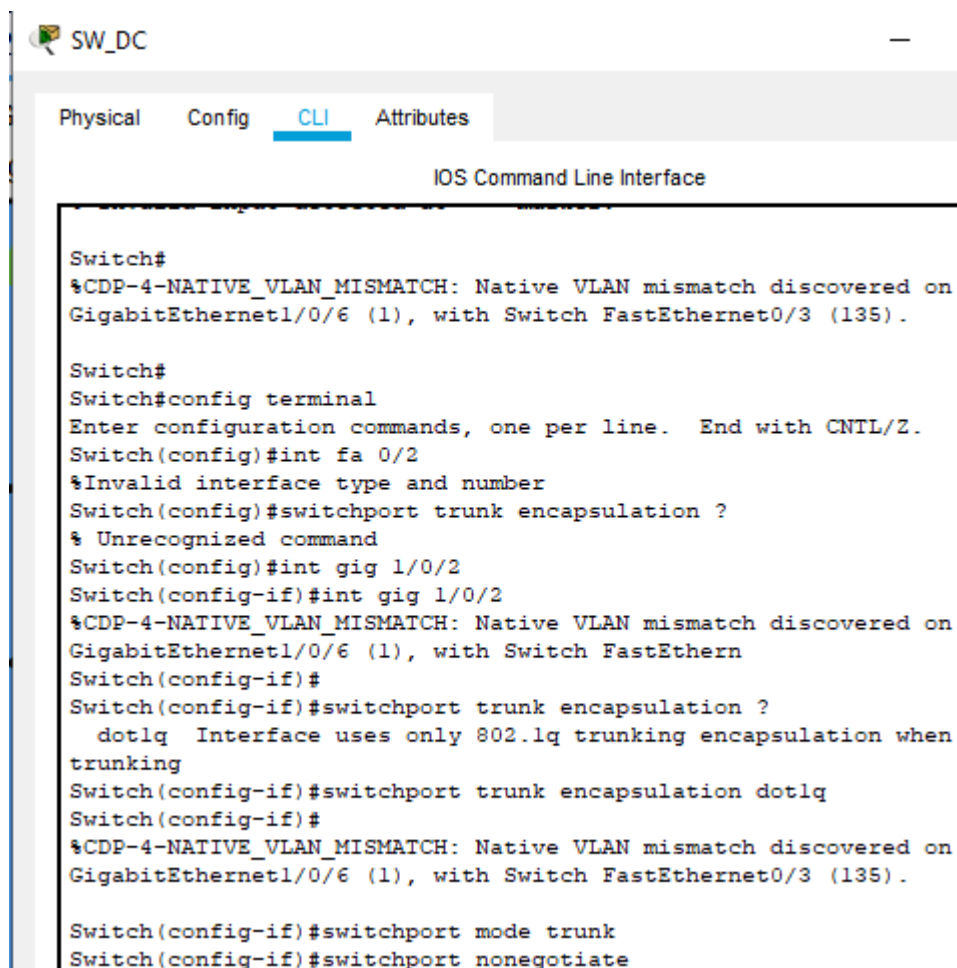
Switch(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2
changed state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2
changed state to up

Switch(config-if)#switchport mode trunk
Switch(config-if)#switchport trunk native vlan 135
Switch(config-if)#switchport nonegotiate

```

Figura 12 – Configuração interface modo trunk



```
SW_DC
Physical Config CLI Attributes
IOS Command Line Interface

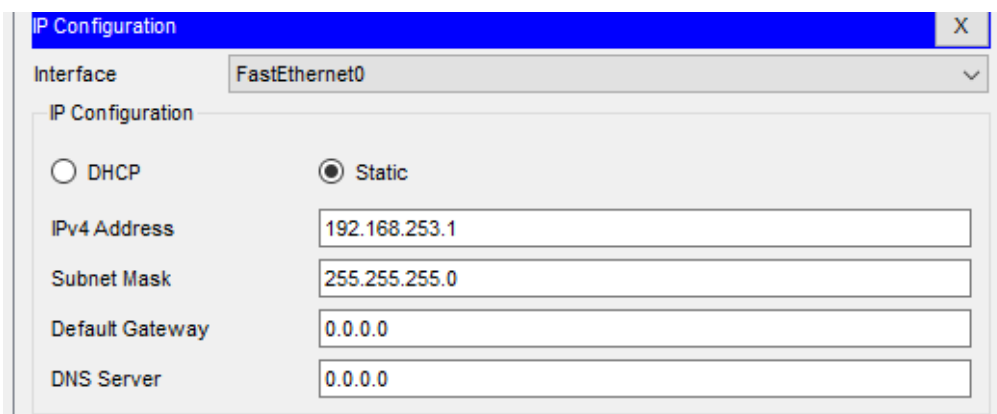
Switch#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet1/0/6 (1), with Switch FastEthernet0/3 (135).

Switch#
Switch#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#int fa 0/2
%Invalid interface type and number
Switch(config)#switchport trunk encapsulation ?
% Unrecognized command
Switch(config)#int gig 1/0/2
Switch(config-if)#int gig 1/0/2
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet1/0/6 (1), with Switch FastEthernet
Switch(config-if)#
Switch(config-if)#switchport trunk encapsulation ?
    dot1q Interface uses only 802.1q trunking encapsulation when
trunking
Switch(config-if)#switchport trunk encapsulation dot1q
Switch(config-if)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet1/0/6 (1), with Switch FastEthernet0/3 (135).

Switch(config-if)#switchport mode trunk
Switch(config-if)#switchport nonegotiate
```

Figura 13 - Configuração interface modo trunk switch DC

- c) Para configurar o endereço IP dos pcs foi utilizada a tabela e a configuração foi feita acedendo ao pc, do pc acedendo ao Desktop e de seguida seleccionar o IP Configuration. Os IPs seguem a tabela do enunciado e calculo respetivo. Um exemplo de IP atribuído a uma máquina foi:



IP Configuration

Interface: FastEthernet0

IP Configuration

☐ DHCP ☒ Static

IPv4 Address: 192.168.253.1

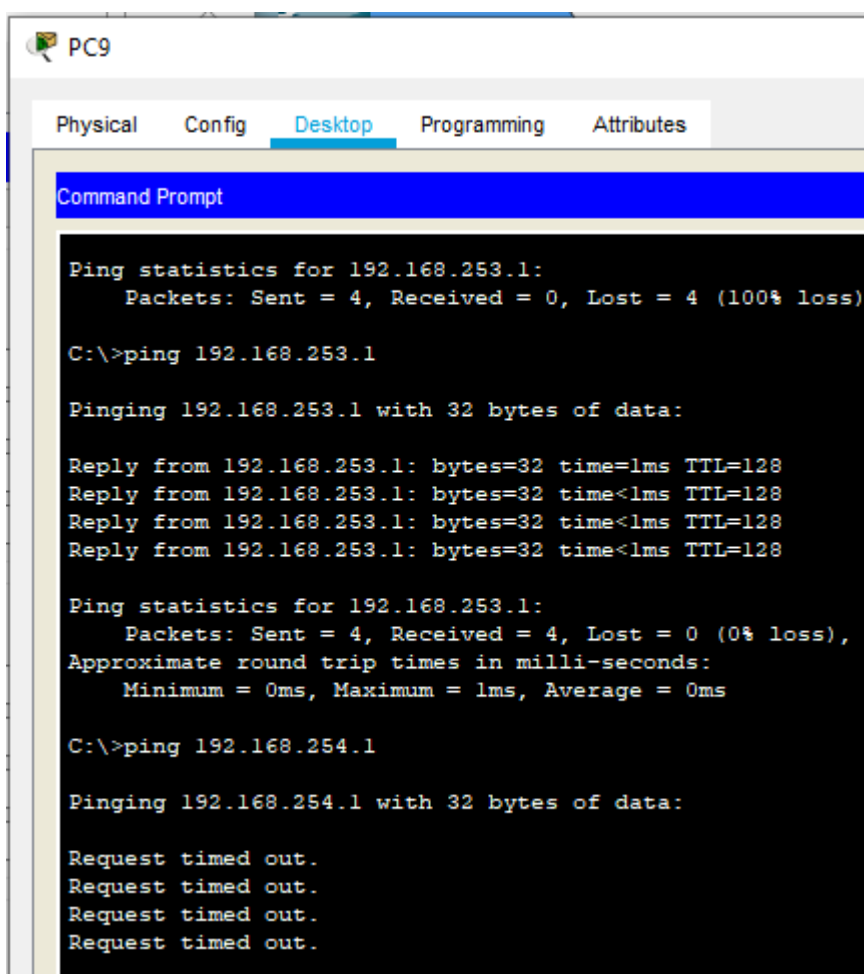
Subnet Mask: 255.255.255.0

Default Gateway: 0.0.0.0

DNS Server: 0.0.0.0

Figura 14 - Atribuição do endereço IP ao pc 7

d), e) Os resultados obtidos ao executar o comando ping entre os pcs foram os seguintes:



```
PC9
Physical  Config  Desktop  Programming  Attributes

Command Prompt

Ping statistics for 192.168.253.1:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss)

C:\>ping 192.168.253.1

Pinging 192.168.253.1 with 32 bytes of data:

Reply from 192.168.253.1: bytes=32 time=1ms TTL=128
Reply from 192.168.253.1: bytes=32 time<1ms TTL=128
Reply from 192.168.253.1: bytes=32 time<1ms TTL=128
Reply from 192.168.253.1: bytes=32 time<1ms TTL=128

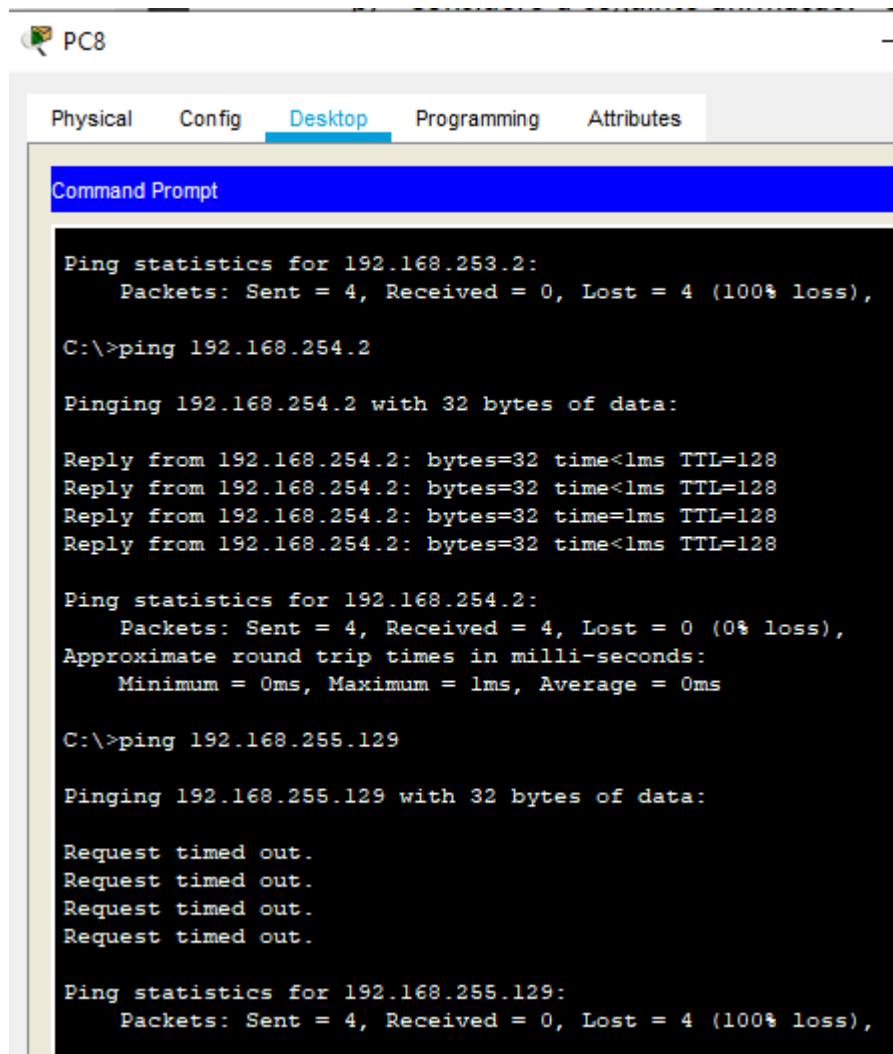
Ping statistics for 192.168.253.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 192.168.254.1

Pinging 192.168.254.1 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.
```

Figura 15 - ping entre PC5 e PC8, ping entre PC8 e PC6



The screenshot shows the configuration window for PC8 in a network simulator. The 'Desktop' tab is selected, and a 'Command Prompt' window is open. The prompt displays the results of two ping commands. The first command, 'ping 192.168.253.2', shows a 100% loss of packets. The second command, 'ping 192.168.254.2', shows successful results with 0% loss and a 1ms response time. The third command, 'ping 192.168.255.129', shows a 100% loss of packets due to request timeouts.

```
PC8
Physical Config Desktop Programming Attributes
Command Prompt

Ping statistics for 192.168.253.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 192.168.254.2

Pinging 192.168.254.2 with 32 bytes of data:

Reply from 192.168.254.2: bytes=32 time<1ms TTL=128
Reply from 192.168.254.2: bytes=32 time<1ms TTL=128
Reply from 192.168.254.2: bytes=32 time=1ms TTL=128
Reply from 192.168.254.2: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.254.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 192.168.255.129

Pinging 192.168.255.129 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.255.129:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

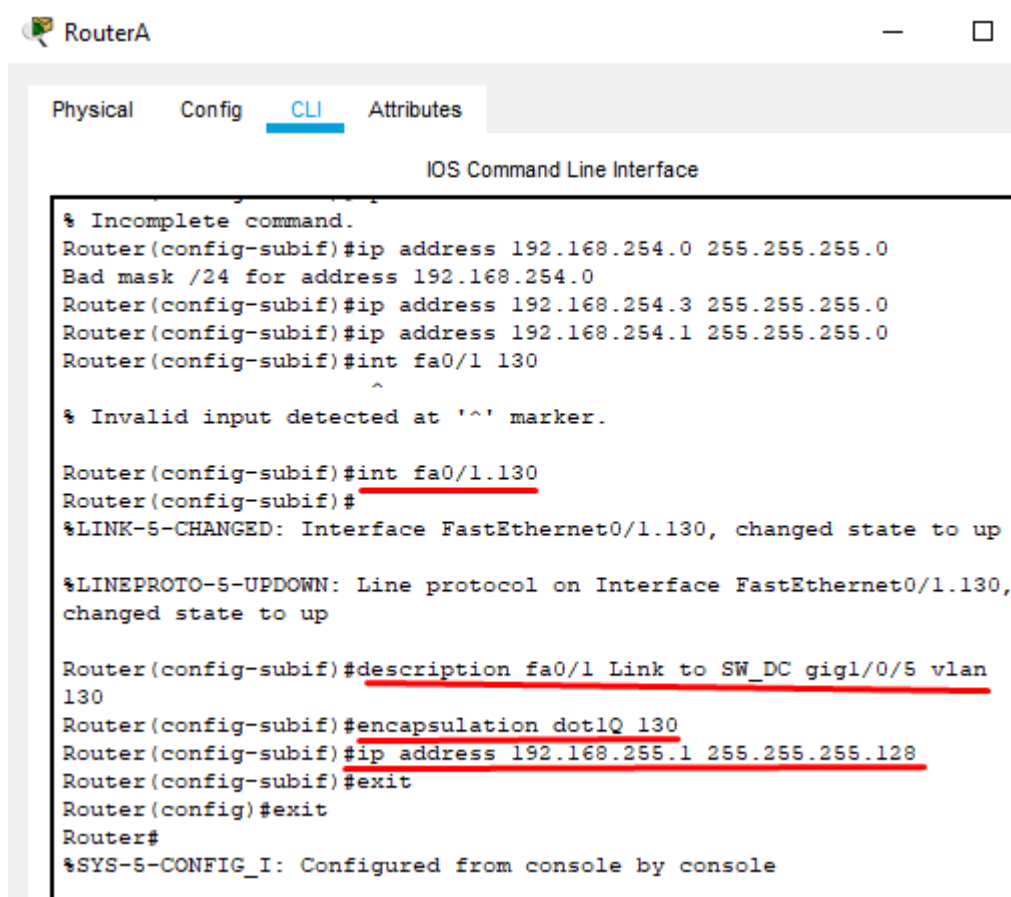
Figura 16 - ping entre PC8 e PC5, ping entre PC8 e PC6

## Tarefa 3

- a) Para iniciar a comunicação entre as diferentes VLANs distintas foi utilizado um router, neste caso o routerA. Através de configurações de subinterfaces no router e da configuração do *default gateway* foi possível comunicar entre todas as VLANs.

Para prevenir que a VLAN da Contabilidade comunicasse com as restantes VLANs removeu-se a possibilidade da VLAN, neste caso 110, enviar pacotes do SW\_DC para o router através da ligação trunk.

Para a possibilidade do pc6 conseguir configurar os equipamentos, mas não comunicar com os restantes equipamentos configurou-se a VLAN da gestão (135) com o endereço IP da rede.



```
% Incomplete command.
Router(config-subif)#ip address 192.168.254.0 255.255.255.0
Bad mask /24 for address 192.168.254.0
Router(config-subif)#ip address 192.168.254.3 255.255.255.0
Router(config-subif)#ip address 192.168.254.1 255.255.255.0
Router(config-subif)#int fa0/1 130
^
% Invalid input detected at '^' marker.


Router(config-subif)#int fa0/1.130
Router(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet0/1.130, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1.130,
changed state to up

Router(config-subif)#description fa0/1 Link to SW_DC gig1/0/5 vlan
130
Router(config-subif)#encapsulation dot1Q 130
Router(config-subif)#ip address 192.168.255.1 255.255.255.128
Router(config-subif)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

Figura 17 - Configuração da VLAN 130 com o endereço IP



 RouterA
 

Physical   Config   CLI   Attributes

IOS Command Line Interface

```


%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1
changed state to up

Router(config-if)#exit
Router(config)#int fa0/1.120
Router(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet0/1.120, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1
changed state to up

Router(config-subif)#description fa 0/1 Link to SW_DC gig1/0/5
Router(config-subif)#description fa 0/1 Link to SW DC gig1/0/5
120
Router(config-subif)#encapsulation dot1q 120
Router(config-subif)#
Router(config-subif)#ip address 192.168.254.0
% Incomplete command.
Router(config-subif)#ip address 192.168.254.0 255.255.255.0
Bad mask /24 for address 192.168.254.0
Router(config-subif)#ip address 192.168.254.3 255.255.255.0
Router(config-subif)#ip address 192.168.254.1 255.255.255.0
  
```

Figura 18 - Configuração VLAN secretariado

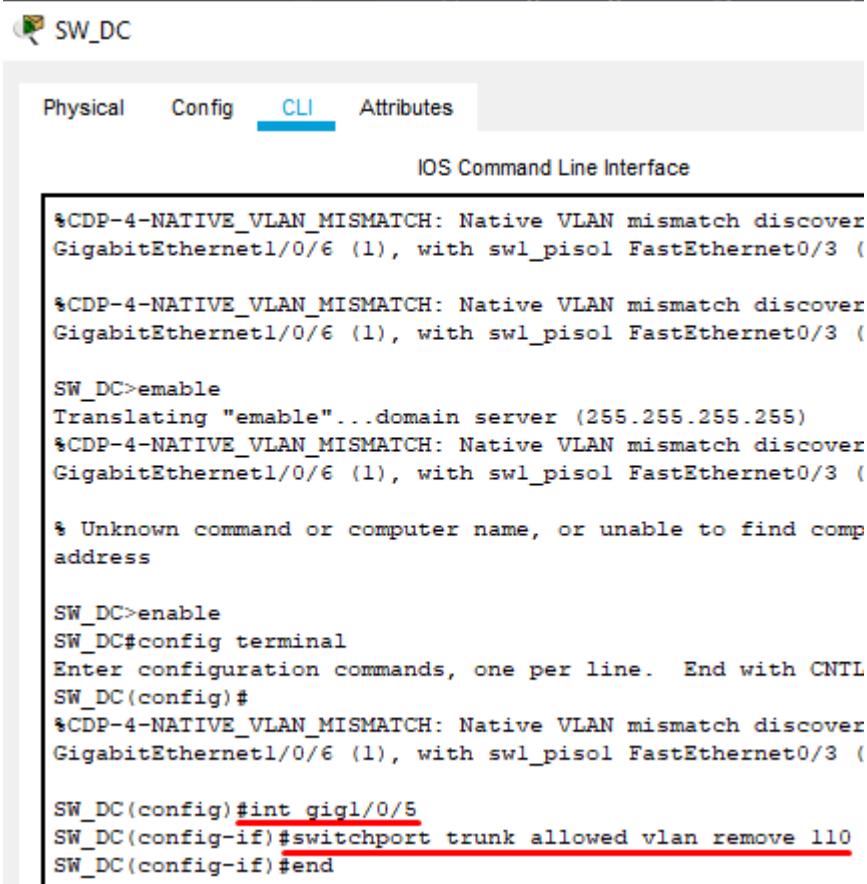
 PC7
 

Physical   Config   Desktop   Programming   Att

IP Configuration

Interface	FastEthernet0
IP Configuration	
<input type="radio"/> DHCP	<input checked="" type="radio"/> Static
IPv4 Address	192.168.253.3
Subnet Mask	255.255.255.0
Default Gateway	192.168.253.1

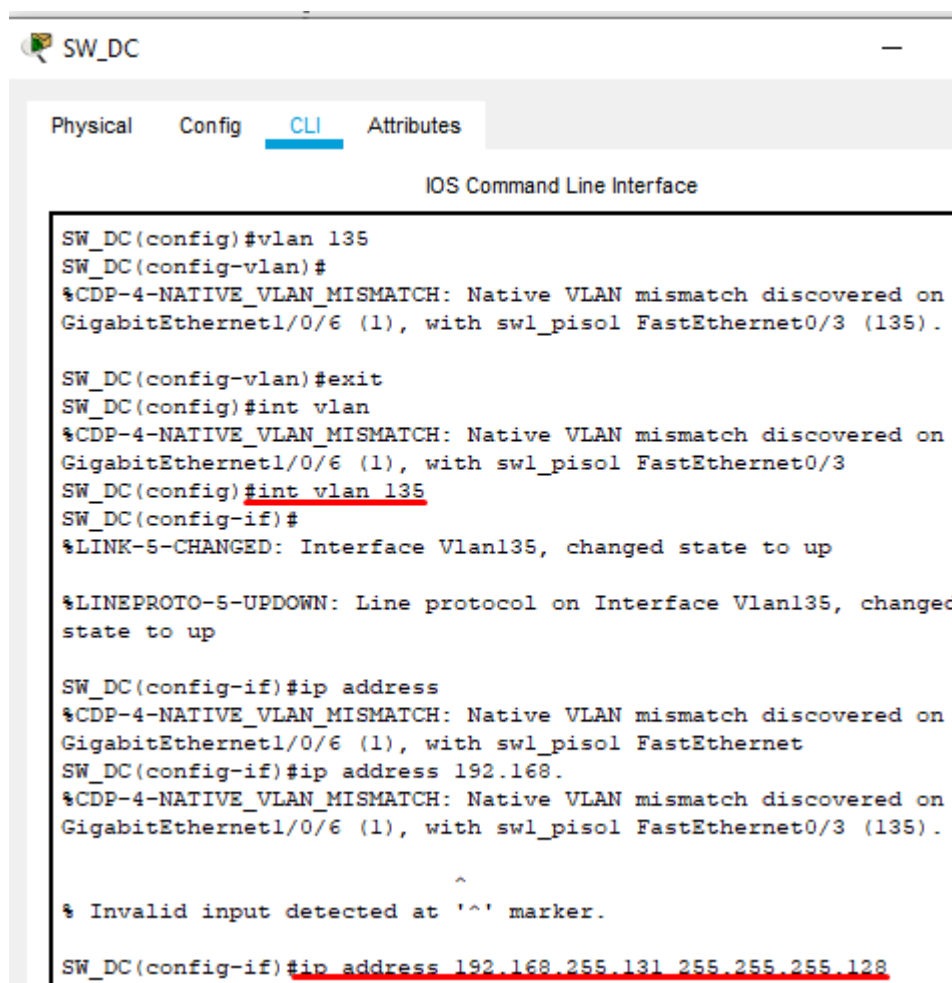
Figura 19 - Configuração do gateway do PC7 de acordo com o endereço IP da sub-interface do router



The screenshot shows the CLI interface of a switch named SW\_DC. The 'CLI' tab is selected. The interface displays several CDP error messages and the following commands:

```
SW_DC>enable
Translating "enable"...domain server (255.255.255.255)
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered
GigabitEthernet1/0/6 (1), with swl_pisol FastEthernet0/3 (
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered
GigabitEthernet1/0/6 (1), with swl_pisol FastEthernet0/3 (
SW_DC>enable
SW_DC#config terminal
Enter configuration commands, one per line. End with CNTL
SW_DC(config)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered
GigabitEthernet1/0/6 (1), with swl_pisol FastEthernet0/3 (
SW_DC(config)#int gig1/0/5
SW_DC(config-if)#switchport trunk allowed vlan remove 110
SW_DC(config-if)#end
```

Figura 20 - Configuração da ligação para não deixar passar a contabilidade



```

SW_DC
Physical Config CLI Attributes
IOS Command Line Interface

SW_DC(config)#vlan 135
SW_DC(config-vlan)#
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet1/0/6 (1), with swl_pisol FastEthernet0/3 (135).

SW_DC(config-vlan)#exit
SW_DC(config)#int vlan
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet1/0/6 (1), with swl_pisol FastEthernet0/3
SW_DC(config)#int vlan 135
SW_DC(config-if)#
%LINK-5-CHANGED: Interface Vlan135, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan135, changed
state to up

SW_DC(config-if)#ip address
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet1/0/6 (1), with swl_pisol FastEthernet
SW_DC(config-if)#ip address 192.168.
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet1/0/6 (1), with swl_pisol FastEthernet0/3 (135).

^
% Invalid input detected at '^' marker.

SW_DC(config-if)#ip address 192.168.255.131 255.255.255.128

```

Figura 21 - Configuração da VLAN 135 com o endereço IP

- b) Para a atribuição do nome aos equipamentos na CLI foi utilizado o comando *hostname* X, onde X representa o nome pretendido.

```

Router>
Router>enable
Router#config terminal
Enter configuration commands, one p
Router(config)#hostname RouterA
RouterA(config)#exit

```

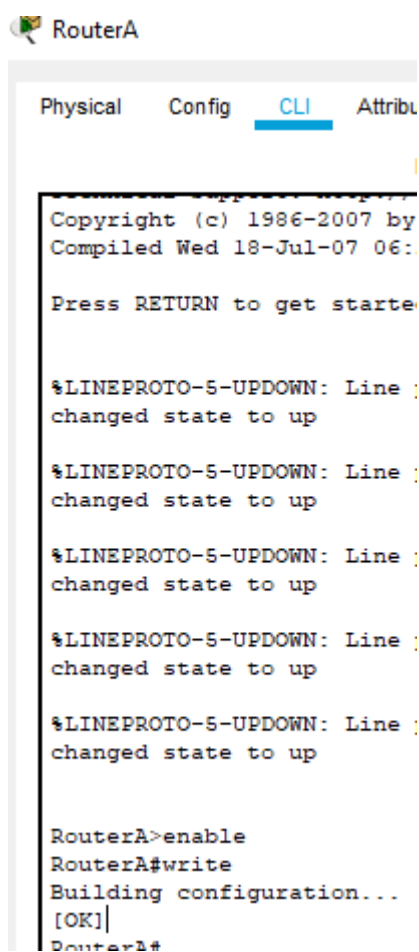
Figura 22 - Atribuição do nome ao router

- c) Para configurar a mensagem inicial foi utilizado o comando *banner login ^C*.

```
RouterA>enable
RouterA#config terminal
Enter configuration commands, one per line. End with C
RouterA(config)#banner login ^C
Enter TEXT message. End with the character '^'.
banner login ^
```

Figura 23 - Configuração da mensagem inicial

- d) Para salvar as configurações foi feito o comando *write*.

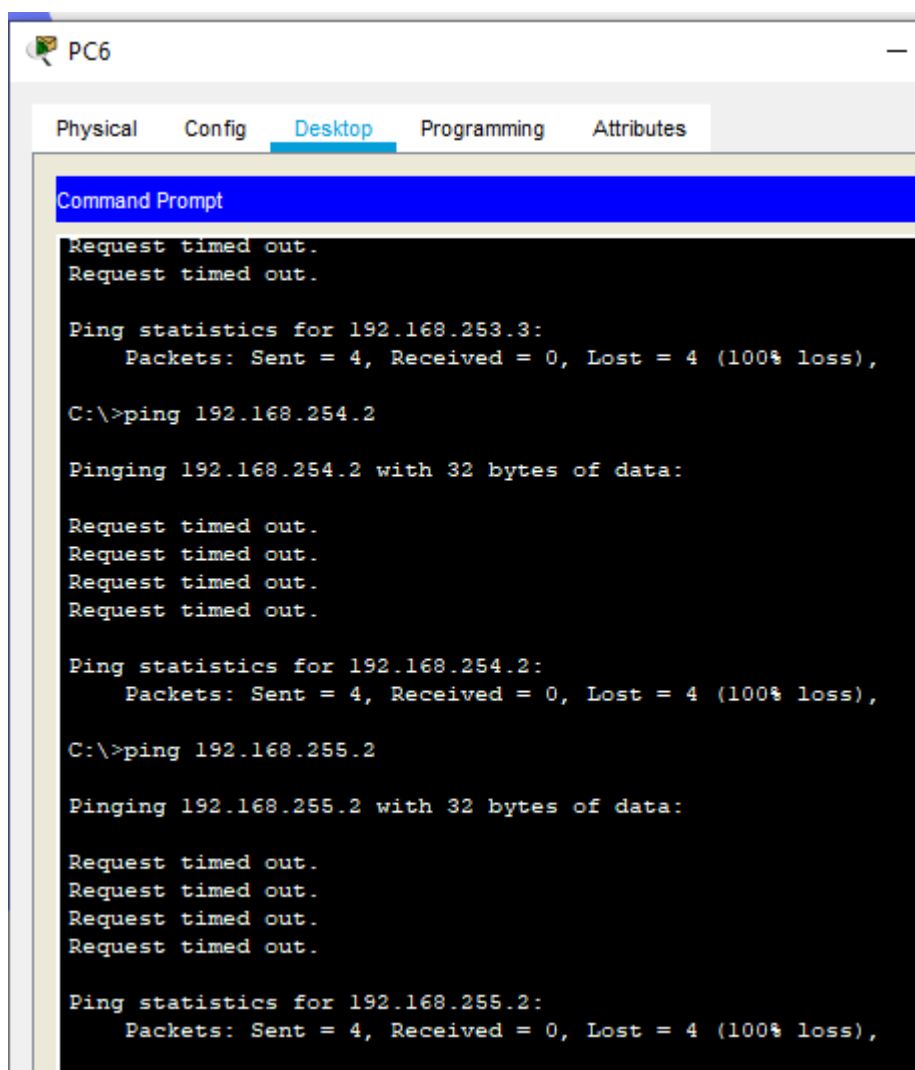


The screenshot shows the RouterA CLI interface with the 'CLI' tab selected. The output displays the router's startup banner, followed by status messages for line protocols. At the bottom, the user enters the 'enable' command, then the 'write' command to save the configuration. The system responds with 'Building configuration...' and '[OK]'.

```
RouterA
Physical Config CLI Attribute
Copyright (c) 1986-2007 by
Compiled Wed 18-Jul-07 06:
Press RETURN to get starte
%LINEPROTO-5-UPDOWN: Line ;
changed state to up
%LINEPROTO-5-UPDOWN: Line ;
changed state to up
%LINEPROTO-5-UPDOWN: Line ;
changed state to up
%LINEPROTO-5-UPDOWN: Line ;
changed state to up
%LINEPROTO-5-UPDOWN: Line ;
changed state to up
RouterA>enable
RouterA#write
Building configuration...
[OK]
RouterA#
```

Figura 24 - Comando write para escrever os comandos

e) Os resultados obtidos foram os que se seguem:



The screenshot shows a Packet Tracer PC6 desktop environment. The 'Desktop' tab is selected, displaying a 'Command Prompt' window. The command prompt shows the results of three ping commands executed from the PC. All three ping attempts resulted in 100% packet loss.

```
PC6
Physical Config Desktop Programming Attributes
Command Prompt
Request timed out.
Request timed out.

Ping statistics for 192.168.253.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 192.168.254.2

Pinging 192.168.254.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.254.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

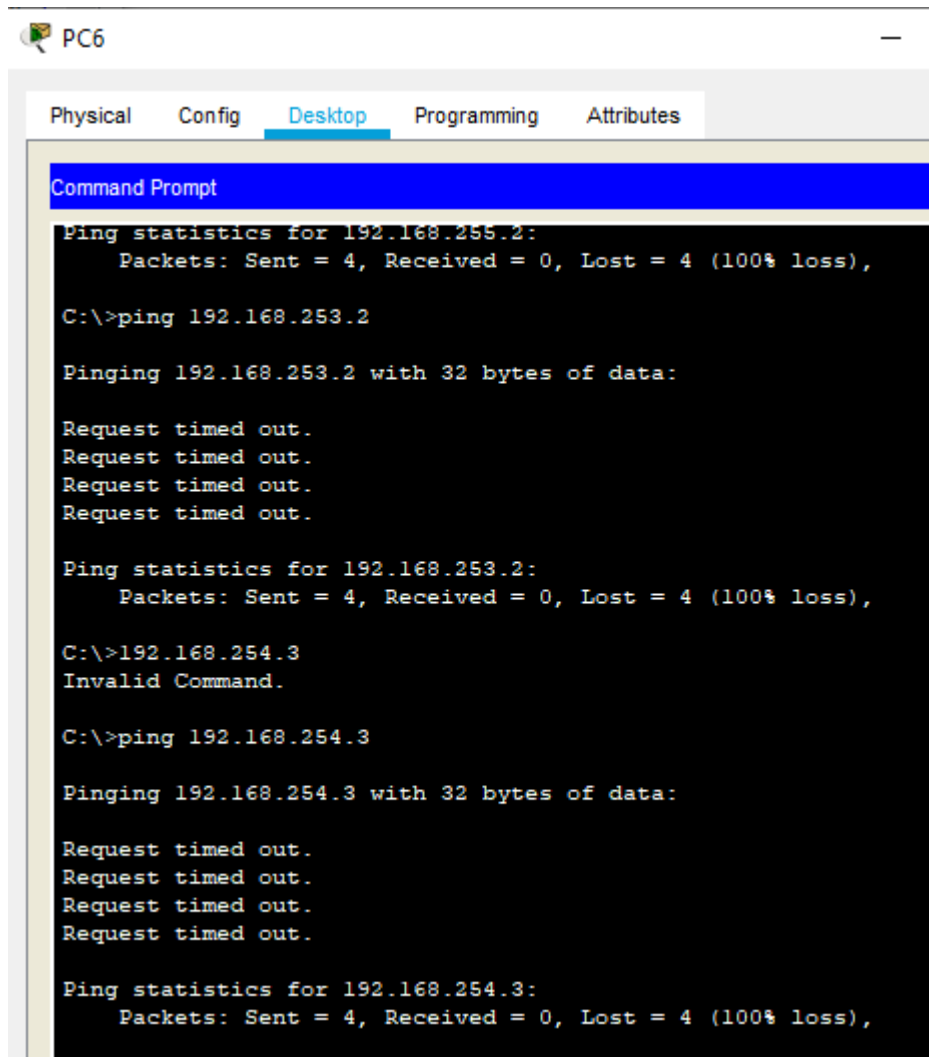
C:\>ping 192.168.255.2

Pinging 192.168.255.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.255.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figura 25 - ping entre pc6 - pc5, server2



The screenshot shows a window titled "PC6" with a tabbed interface. The "Desktop" tab is active, displaying a "Command Prompt" window. The command prompt shows the results of two ping commands. The first command is "ping 192.168.253.2", which results in a 100% loss of packets. The second command is "ping 192.168.254.3", which also results in a 100% loss of packets. The output for both commands is identical, showing four sent packets, zero received packets, and four lost packets (100% loss).

```
Physical Config Desktop Programming Attributes
Command Prompt
Ping statistics for 192.168.253.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 192.168.253.2

Pinging 192.168.253.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.253.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>192.168.254.3
Invalid Command.

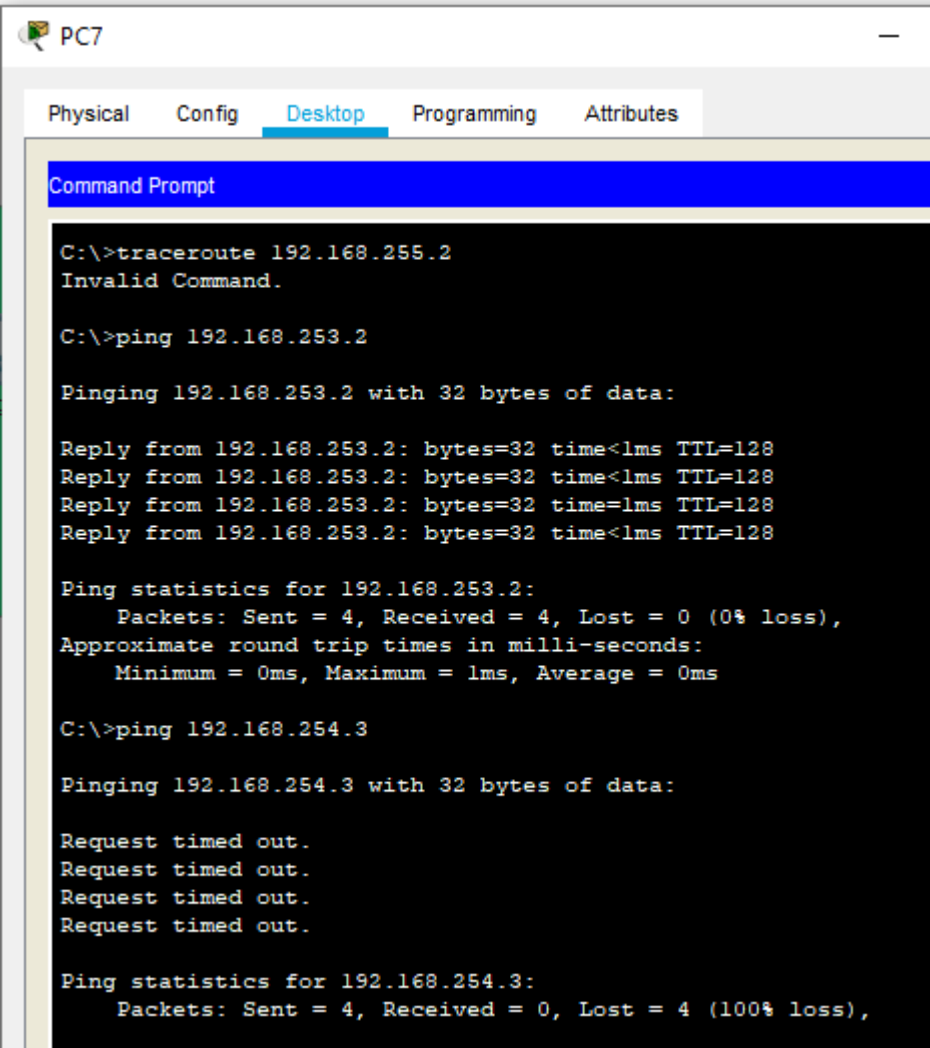
C:\>ping 192.168.254.3

Pinging 192.168.254.3 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.254.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figura 26 - ping pc6 - pc9, 8



The screenshot shows a Packet Tracer configuration window for PC7. The 'Desktop' tab is selected, displaying a Command Prompt. The user has entered the following commands and received the following output:

```
C:\>tracert 192.168.255.2
Invalid Command.

C:\>ping 192.168.253.2

Pinging 192.168.253.2 with 32 bytes of data:

Reply from 192.168.253.2: bytes=32 time<1ms TTL=128
Reply from 192.168.253.2: bytes=32 time<1ms TTL=128
Reply from 192.168.253.2: bytes=32 time=1ms TTL=128
Reply from 192.168.253.2: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.253.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

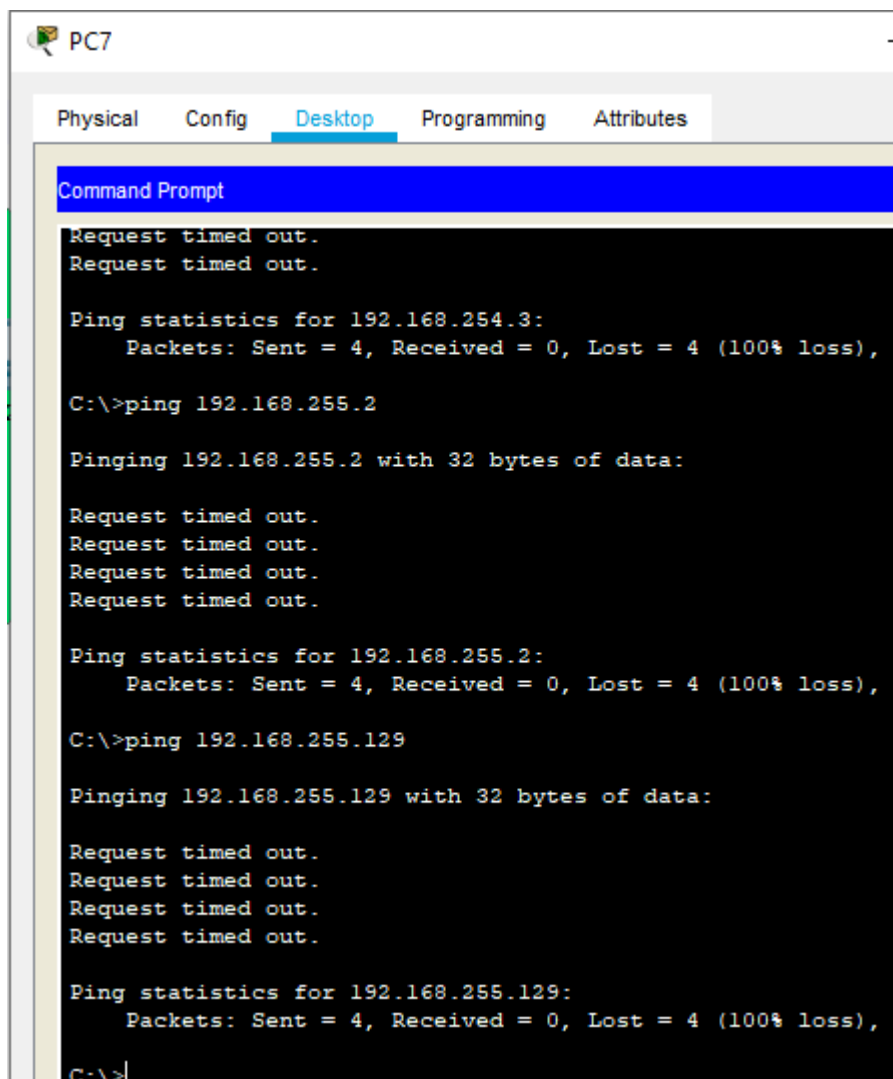
C:\>ping 192.168.254.3

Pinging 192.168.254.3 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.254.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figura 27 - ping pc7 - pc9, pc8



The screenshot shows a PC7 window with tabs for Physical, Config, Desktop, Programming, and Attributes. The Desktop tab is active, displaying a Command Prompt window. The Command Prompt shows the results of two ping commands. The first command is 'ping 192.168.254.3', which results in four 'Request timed out.' messages and a summary: 'Ping statistics for 192.168.254.3: Packets: Sent = 4, Received = 0, Lost = 4 (100% loss)'. The second command is 'ping 192.168.255.2', which also results in four 'Request timed out.' messages and a summary: 'Ping statistics for 192.168.255.2: Packets: Sent = 4, Received = 0, Lost = 4 (100% loss)'. The third command is 'ping 192.168.255.129', which also results in four 'Request timed out.' messages and a summary: 'Ping statistics for 192.168.255.129: Packets: Sent = 4, Received = 0, Lost = 4 (100% loss)'. The Command Prompt window is titled 'Command Prompt' and the PC7 window is titled 'PC7'.

```
PC7
Physical Config Desktop Programming Attributes
Command Prompt
Request timed out.
Request timed out.

Ping statistics for 192.168.254.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 192.168.255.2

Pinging 192.168.255.2 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.255.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>ping 192.168.255.129

Pinging 192.168.255.129 with 32 bytes of data:

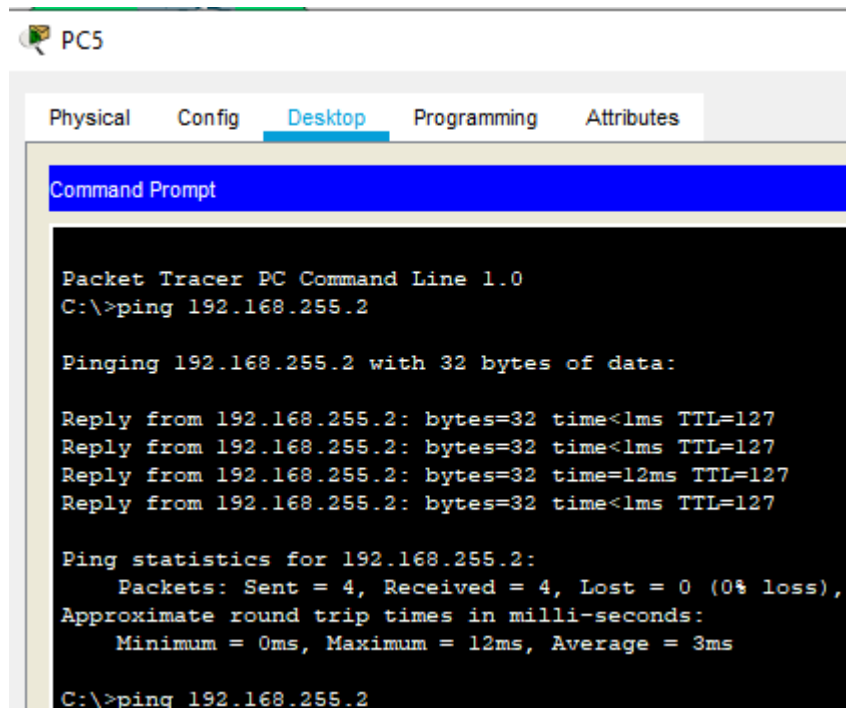
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.255.129:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

Figura 28 - ping pc7 - server 2, pc6





The screenshot shows the 'PC5' configuration window in Packet Tracer, with the 'Desktop' tab selected. A 'Command Prompt' window is open, displaying the output of a ping command. The text in the Command Prompt is as follows:

```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.255.2

Pinging 192.168.255.2 with 32 bytes of data:

Reply from 192.168.255.2: bytes=32 time<1ms TTL=127
Reply from 192.168.255.2: bytes=32 time<1ms TTL=127
Reply from 192.168.255.2: bytes=32 time=12ms TTL=127
Reply from 192.168.255.2: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.255.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 12ms, Average = 3ms
C:\>ping 192.168.255.2
```

Figura 29 - ping pc5 - server2

## Tarefa 4

Neste ponto é necessário a configuração da rede da empresa B. Onde a empresa utiliza endereços IP /24, mas utiliza endereços /27 para efeitos de racionamento de endereçamento.

```
Switch(config-vlan)#vlan 20
Switch(config-vlan)#name Servidores
Switch(config-vlan)#vlan 40
Switch(config-vlan)#name Engenharia
```

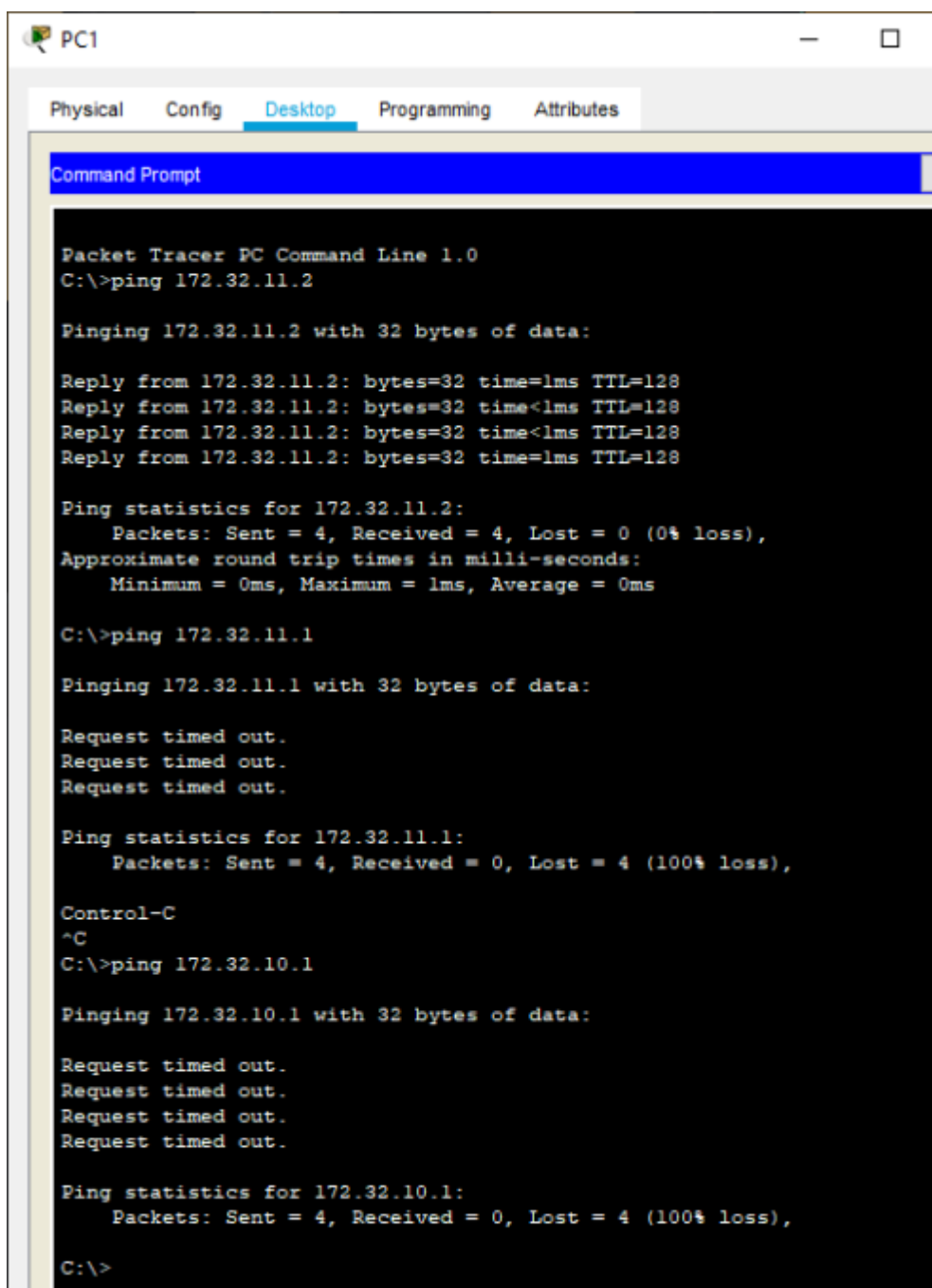
Figura 30 - Atribuição das VLANs

20	Servidores	active
40	Engenharia	active
1002	fddi-default	active
1003	token-ring-default	active
1004	fddinet-default	active
1005	trnet-default	active

Figura 31 - Resultados com o comando show vlan brief

```
Switch(config-if)#switchport mode access
Switch(config-if)#switch
Switch(config-if)#switchport acce
Switch(config-if)#switchport access vlan 40
Switch(config-if)#no shu
Switch(config-if)#no shutdown
Switch(config-if)#
Switch(config-if)#interface fa0/12
Switch(config-if)#
Switch(config-if)#switc
Switch(config-if)#switchport mode acc
Switch(config-if)#switchport mode access
Switch(config-if)#swit
Switch(config-if)#switchport acce
Switch(config-if)#switchport access vlan 40
Switch(config-if)#no s
Switch(config-if)#no sh
Switch(config-if)#no shutdown
```

Figura 32 - Configurações das interfaces no modo access para as VLANs



```
PC1
Physical  Config  Desktop  Programming  Attributes
Command Prompt

Packet Tracer PC Command Line 1.0
C:\>ping 172.32.11.2

Pinging 172.32.11.2 with 32 bytes of data:

Reply from 172.32.11.2: bytes=32 time=1ms TTL=128
Reply from 172.32.11.2: bytes=32 time<1ms TTL=128
Reply from 172.32.11.2: bytes=32 time<1ms TTL=128
Reply from 172.32.11.2: bytes=32 time=1ms TTL=128

Ping statistics for 172.32.11.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 172.32.11.1

Pinging 172.32.11.1 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.

Ping statistics for 172.32.11.1:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

Control-C
^C
C:\>ping 172.32.10.1

Pinging 172.32.10.1 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 172.32.10.1:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\>
```

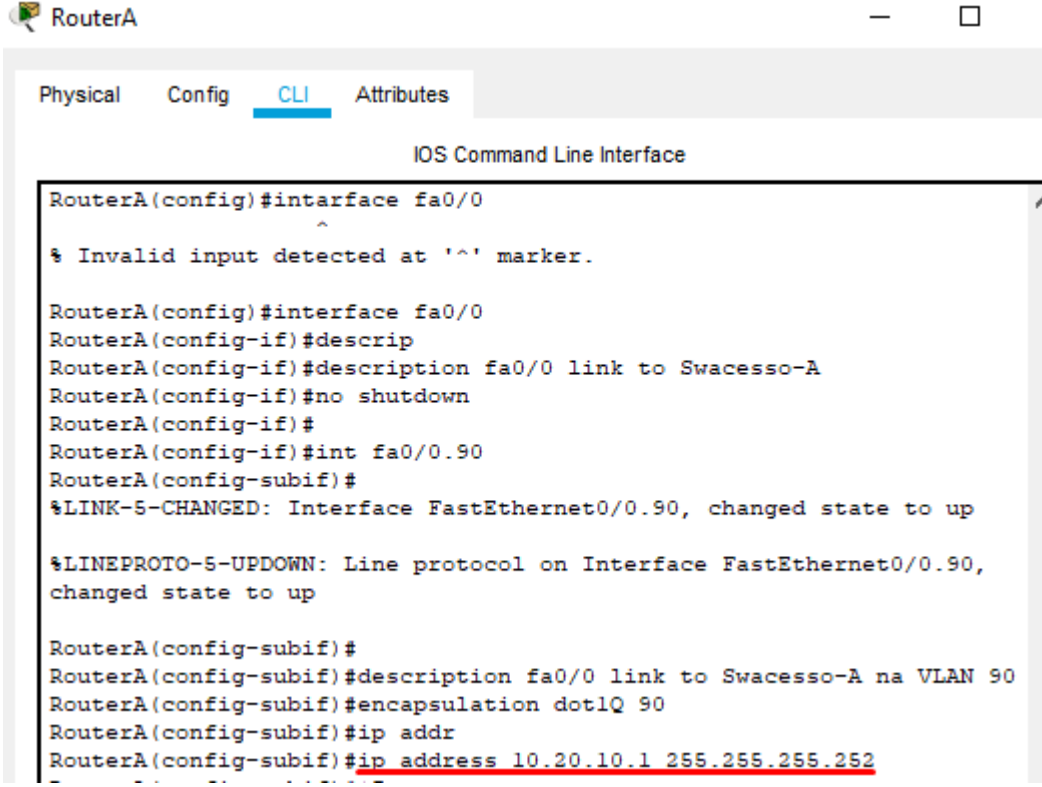
Figura 33 - ping pc1 - pc2, server

Pelas configurações das VLANs é possível comunicar entre o pc1 e o pc2 e não é possível comunicar com o server1 por pertencer a diferentes VLANs.

## Tarefa 5

- a) Pretende-se que seja feita ligações ponto a ponto entre router 1 e 3 para comunicar com o router A e B. Dessa forma foi necessário configurar subinterfaces para fora das redes internas da empresa A e B. Para haver comunicação com o router 1 e 3 foi necessário também configurar subinterfaces para estes receberem os pacotes.

i)



```
RouterA
Physical Config CLI Attributes
IOS Command Line Interface

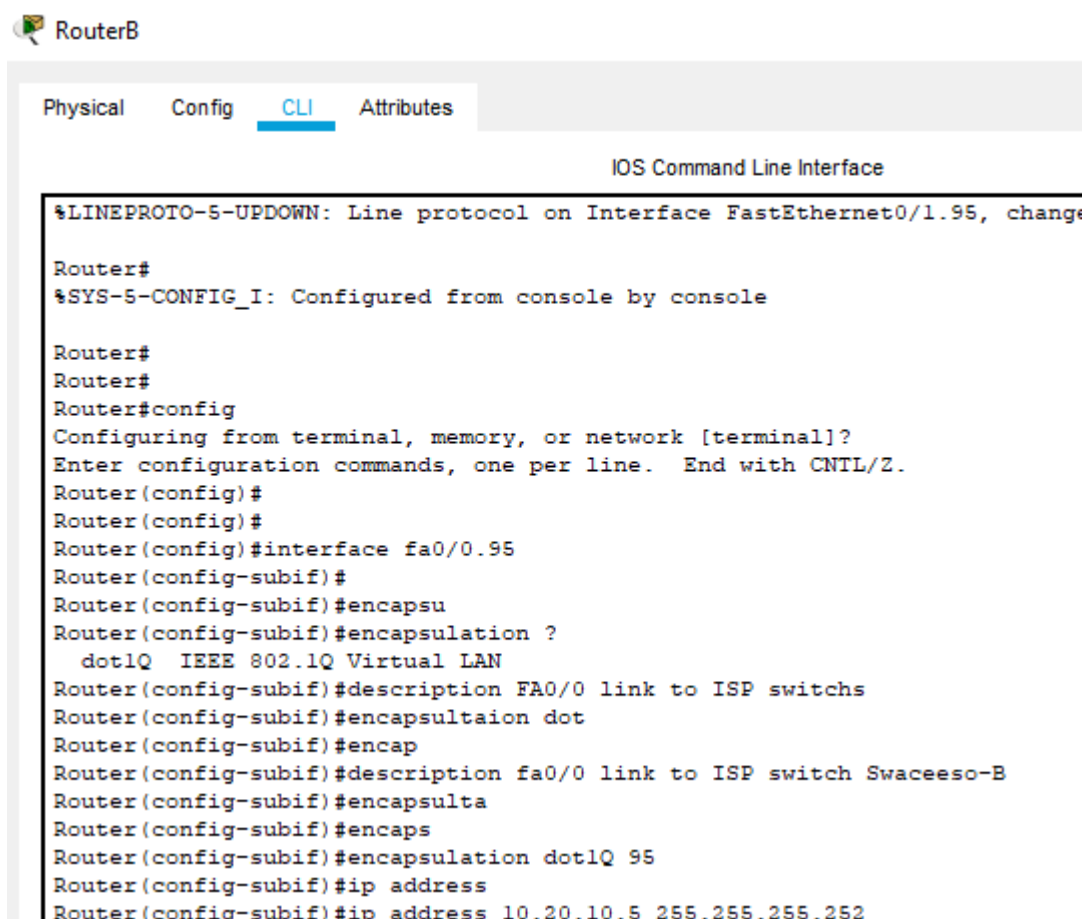
RouterA(config)#interface fa0/0
      ^
% Invalid input detected at '^' marker.

RouterA(config)#interface fa0/0
RouterA(config-if)#descrip
RouterA(config-if)#description fa0/0 link to Swacesso-A
RouterA(config-if)#no shutdown
RouterA(config-if)#
RouterA(config-if)#int fa0/0.90
RouterA(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet0/0.90, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0.90,
changed state to up

RouterA(config-subif)#
RouterA(config-subif)#description fa0/0 link to Swacesso-A na VLAN 90
RouterA(config-subif)#encapsulation dot1Q 90
RouterA(config-subif)#ip addr
RouterA(config-subif)#ip address 10.20.10.1 255.255.255.252
```

ii)



The screenshot shows the Cisco RouterB CLI interface with the 'CLI' tab selected. The interface displays the following commands and prompts:


```
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1.95, changed state to up

Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#
Router#
Router#config
Configuring from terminal, memory, or network [terminal]?
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#
Router(config)#interface fa0/0.95
Router(config-subif)#
Router(config-subif)#encapsu
Router(config-subif)#encapsulation ?
    dot1Q  IEEE 802.1Q Virtual LAN
Router(config-subif)#description FA0/0 link to ISP switchs
Router(config-subif)#encapsultaion dot
Router(config-subif)#encap
Router(config-subif)#description fa0/0 link to ISP switch Swaceeso-B
Router(config-subif)#encapsulta
Router(config-subif)#encaps
Router(config-subif)#encapsulation dot1Q 95
Router(config-subif)#ip address
Router(config-subif)#ip address 10.20.10.5 255.255.255.252
```

**Figura 35 - Configuração da sub-interface router B para fora da empresa**

O endereço IP atribuído ao router B foi posteriormente alterado por conveniência, assim em vez de 10.20.10.5 o endereço utilizado foi 10.20.10.6 com a mesma máscara.

 RouterBPhysical Config CLI Attributes

IOS Command Line Interface

```
Router(config-subif)#encapsulation dot1Q 20
Router(config-subif)#ip address 172.32.10.30
% Incomplete command.
Router(config-subif)#end
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#
%SYS-5-CONFIG_I: Configured from console by console

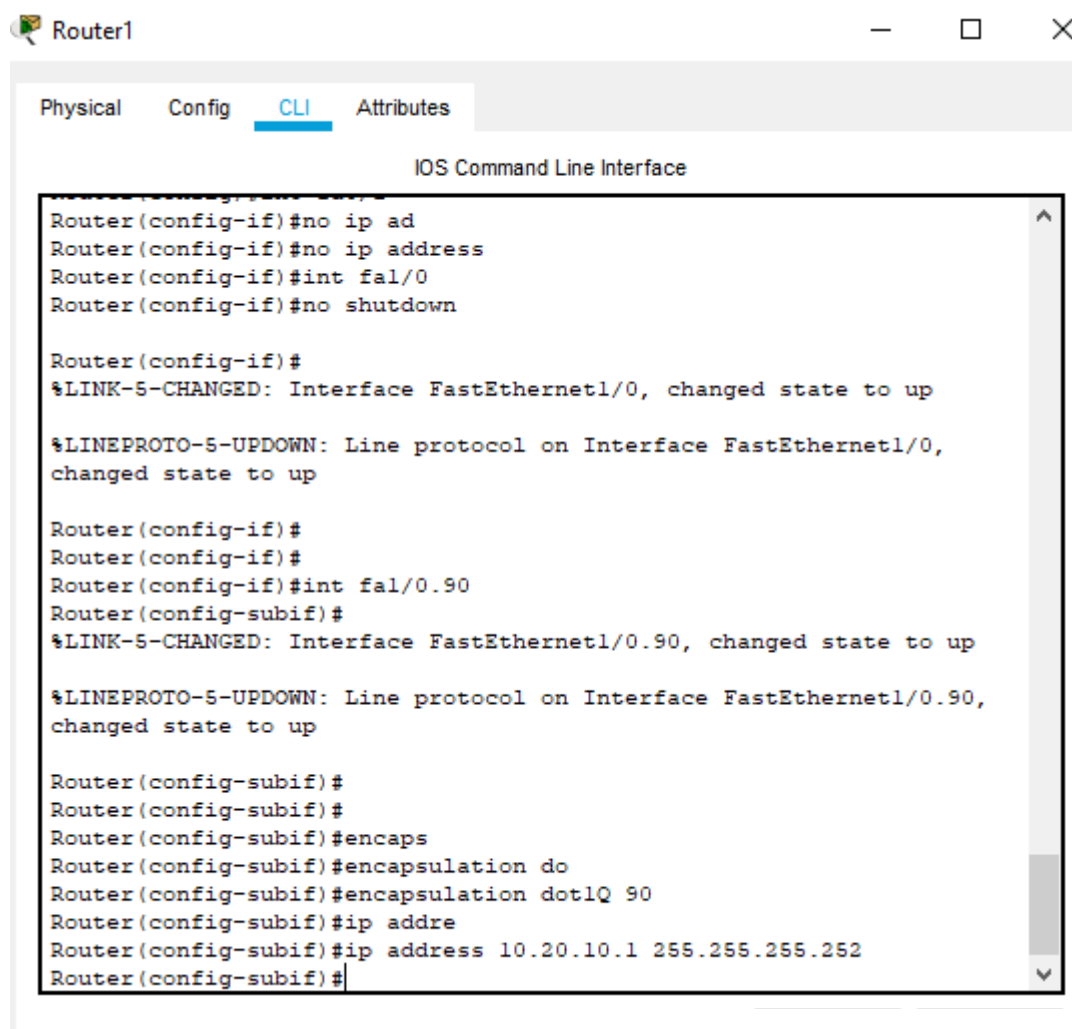
Router(config-if)#ip address 172.32.10.30 255.255.255.252
Router(config-if)#
Router(config-if)#
Router(config-if)#
Router(config-if)#
Router(config-if)#interface fa0/1.40
Router(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet0/1.40, changed state to

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1.

Router(config-subif)#descr
Router(config-subif)#description fa0/1 link to SwempresaB
Router(config-subif)#enca
Router(config-subif)#encapsulation dot1Q 40
Router(config-subif)#ip address 172.32.11.30 255.255.255.252
Router(config-subif)#ip address 172.32.11.30 255.255.255.224
Router(config-subif)#
```

**Figura 36 - Configuração sub-interfaces dentro empresa B**

b) Para poder existir comunicação entre o routerA e o router1 e o routerB e o router3, foi necessário configurar o router1 e o router3 com os seus respectivos endereços IP, obtendo:



```
Router1
Physical Config CLI Attributes
IOS Command Line Interface
Router(config-if)#no ip ad
Router(config-if)#no ip address
Router(config-if)#int fal/0
Router(config-if)#no shutdown

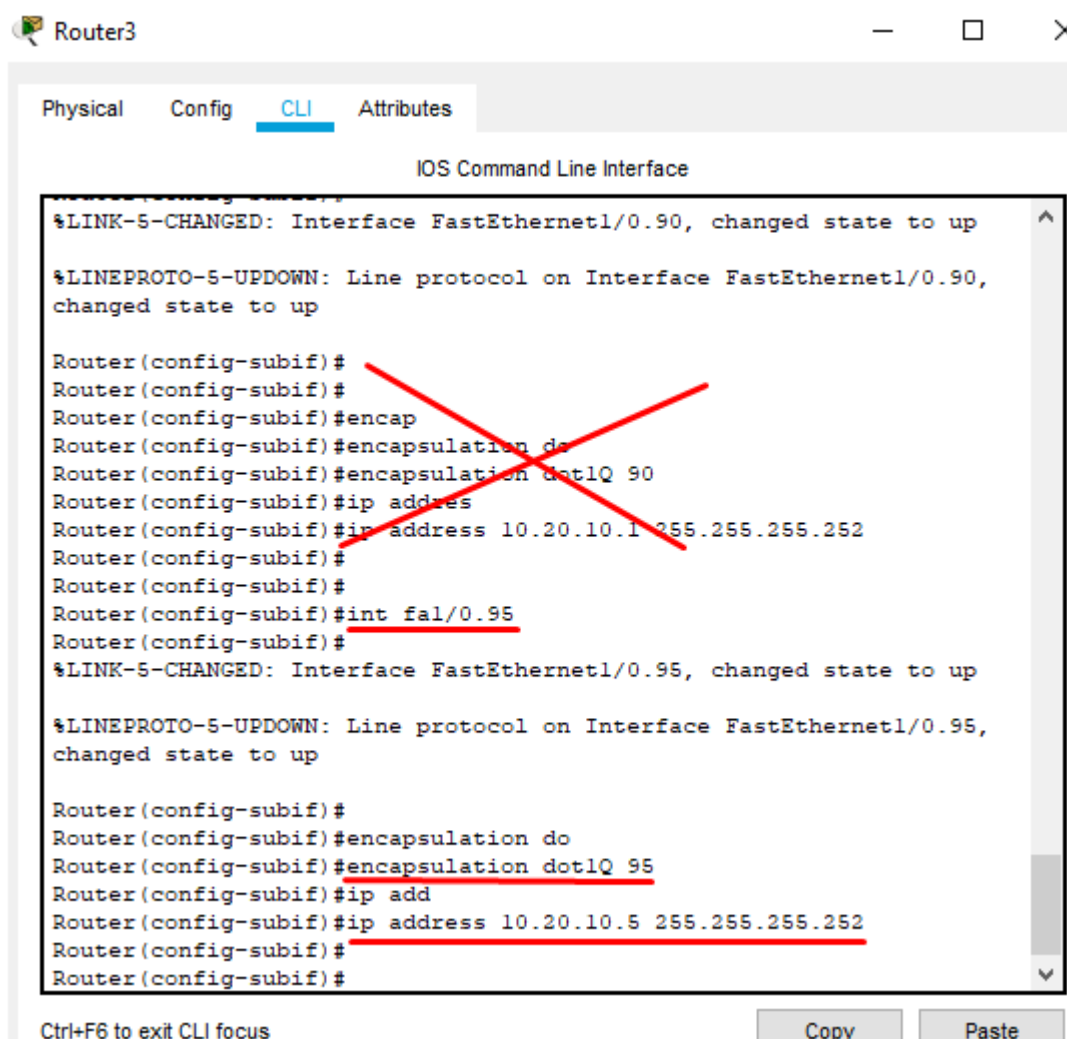
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet1/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0,
changed state to up

Router(config-if)#
Router(config-if)#
Router(config-if)#int fal/0.90
Router(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet1/0.90, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0.90,
changed state to up

Router(config-subif)#
Router(config-subif)#
Router(config-subif)#encaps
Router(config-subif)#encapsulation do
Router(config-subif)#encapsulation dot1Q 90
Router(config-subif)#ip addre
Router(config-subif)#ip address 10.20.10.1 255.255.255.252
Router(config-subif)#
```

Figura 37 - Configuração do router 1 da VLAN 90

Apesar de o endereço ser 10.20.10.1 este foi posteriormente alterado para 10.20.10.2 com a mesma máscara.



```
Router3
Physical Config CLI Attributes
IOS Command Line Interface

%LINK-5-CHANGED: Interface FastEthernet1/0.90, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0.90,
changed state to up

Router(config-subif)#
Router(config-subif)#
Router(config-subif)#encap
Router(config-subif)#encapsulation do
Router(config-subif)#encapsulation dot1Q 90
Router(config-subif)#ip address
Router(config-subif)#ip address 10.20.10.1 255.255.255.252
Router(config-subif)#
Router(config-subif)#
Router(config-subif)#int fa1/0.95
Router(config-subif)#
%LINK-5-CHANGED: Interface FastEthernet1/0.95, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0.95,
changed state to up

Router(config-subif)#
Router(config-subif)#encapsulation do
Router(config-subif)#encapsulation dot1Q 95
Router(config-subif)#ip add
Router(config-subif)#ip address 10.20.10.5 255.255.255.252
Router(config-subif)#
Router(config-subif)#

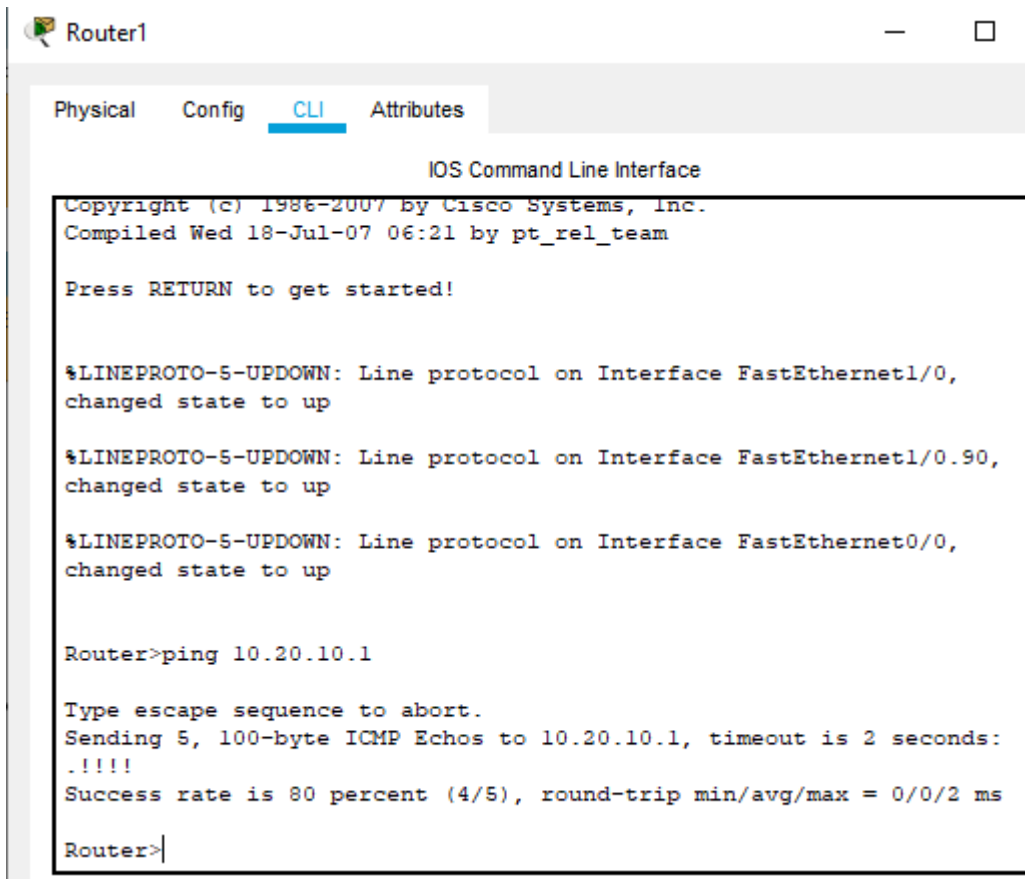
Ctrl+F6 to exit CLI focus Copy Paste
```

Figura 38 - Configuração das VLANs no router 3 da VLAN 90, 95

Apesar de na imagem também estar atribuída um endereço da VLAN 90 no router 3 este foi posteriormente removida.



Para verificar se existe de facto conectividade entre os routers 1 e 3 e os routers A e B, respetivamente, foi feito o ping entre estes equipamentos, obtendo:



```
Router1

Physical  Config  CLI  Attributes

IOS Command Line Interface

Copyright (c) 1986-2007 by Cisco Systems, Inc.
Compiled Wed 18-Jul-07 06:21 by pt_rel_team

Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0,
changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0.90,
changed state to up

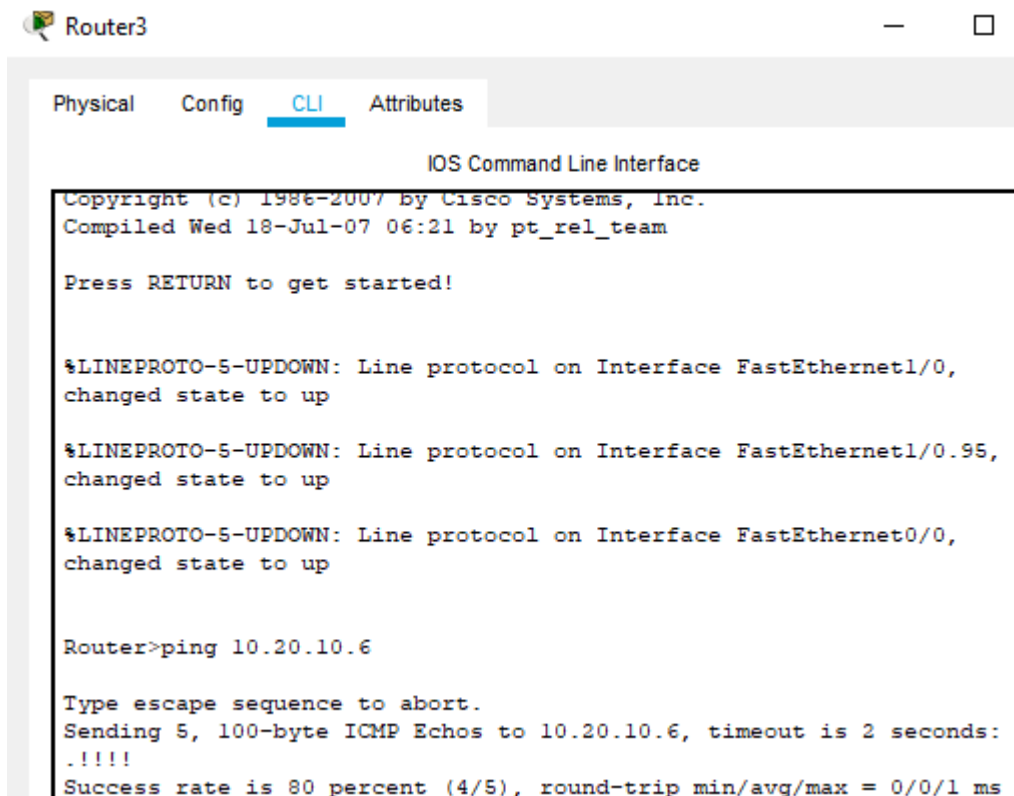
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up

Router>ping 10.20.10.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.20.10.1, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 0/0/2 ms

Router>|
```

Figura 39 - ping do router 1 para o router A



```
Router3

Physical  Config  CLI  Attributes

IOS Command Line Interface

Copyright (c) 1986-2007 by Cisco Systems, Inc.
Compiled Wed 18-Jul-07 06:21 by pt_rel_team

Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0,
changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0.95,
changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up

Router>ping 10.20.10.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.20.10.6, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 0/0/1 ms
```

Figura 40 - ping do router 3 para o router B

c) Neste ponto é necessário configurar os switches que interligam os routers das empresas aos routers 1 e 3.

i) Inicialmente foi necessário configurar o Spanning-tree em todos os switches participantes dentro da topologia.

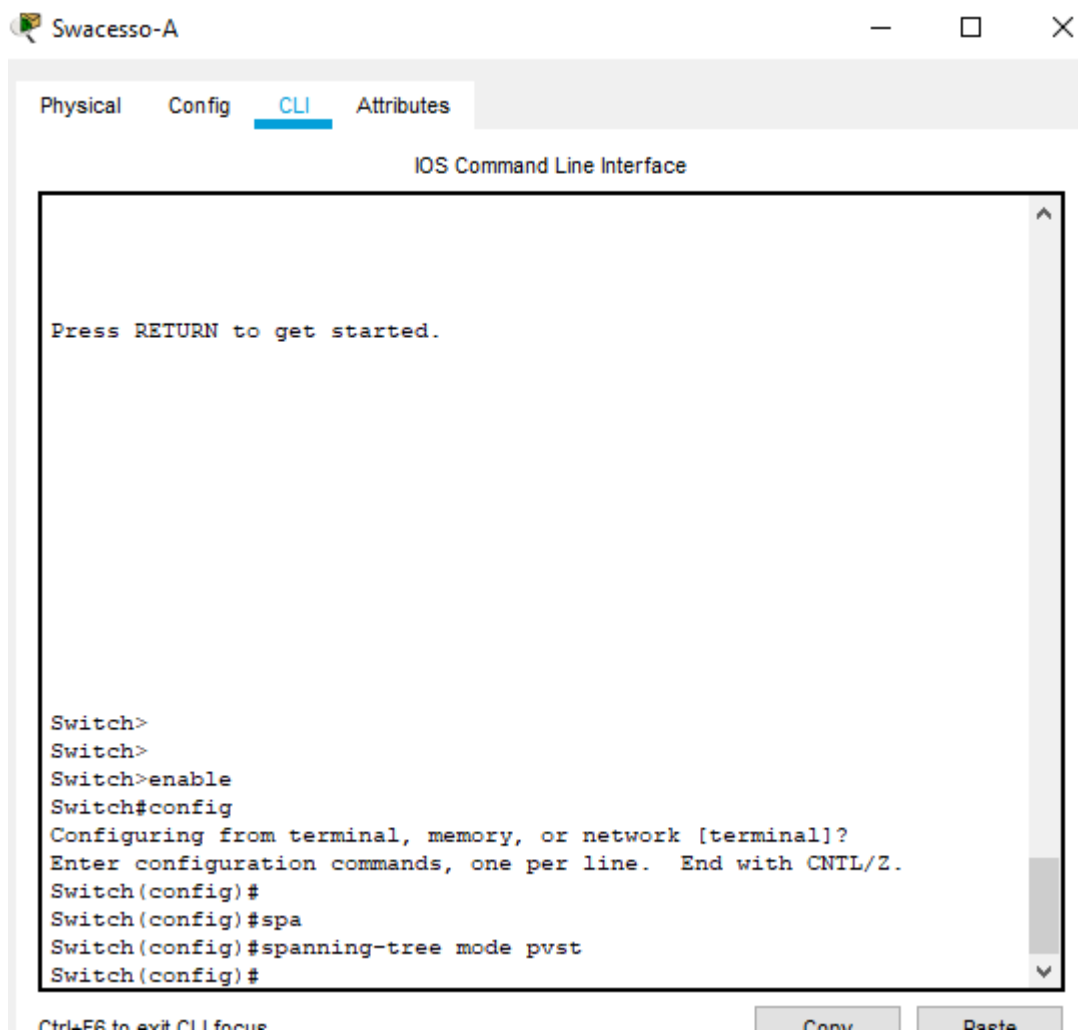
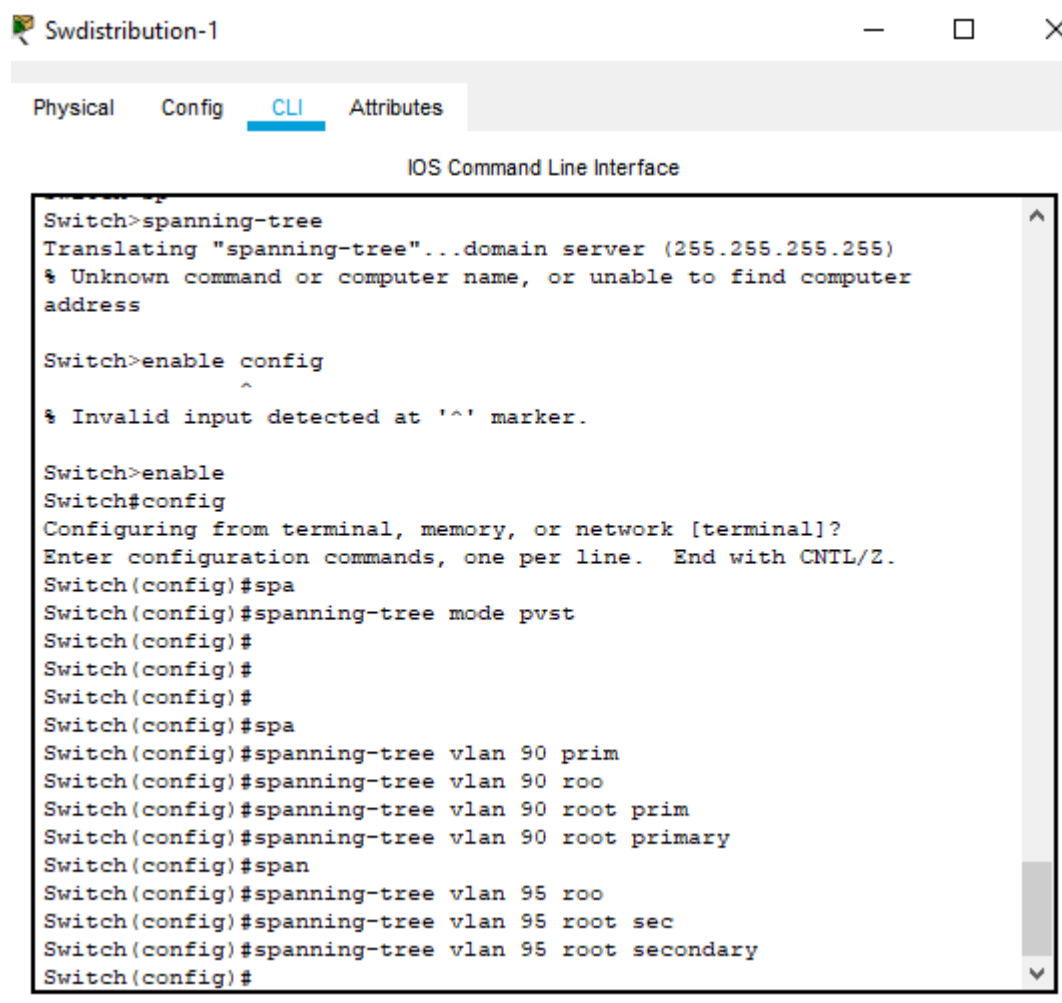


Figura 41 - Configuração do per VLAN Spanning-tree

ii) De seguida foi necessário fazer a eleição do root primary e secondary das VLANs 90 e 95 ao qual corresponde o Swdistribution-1



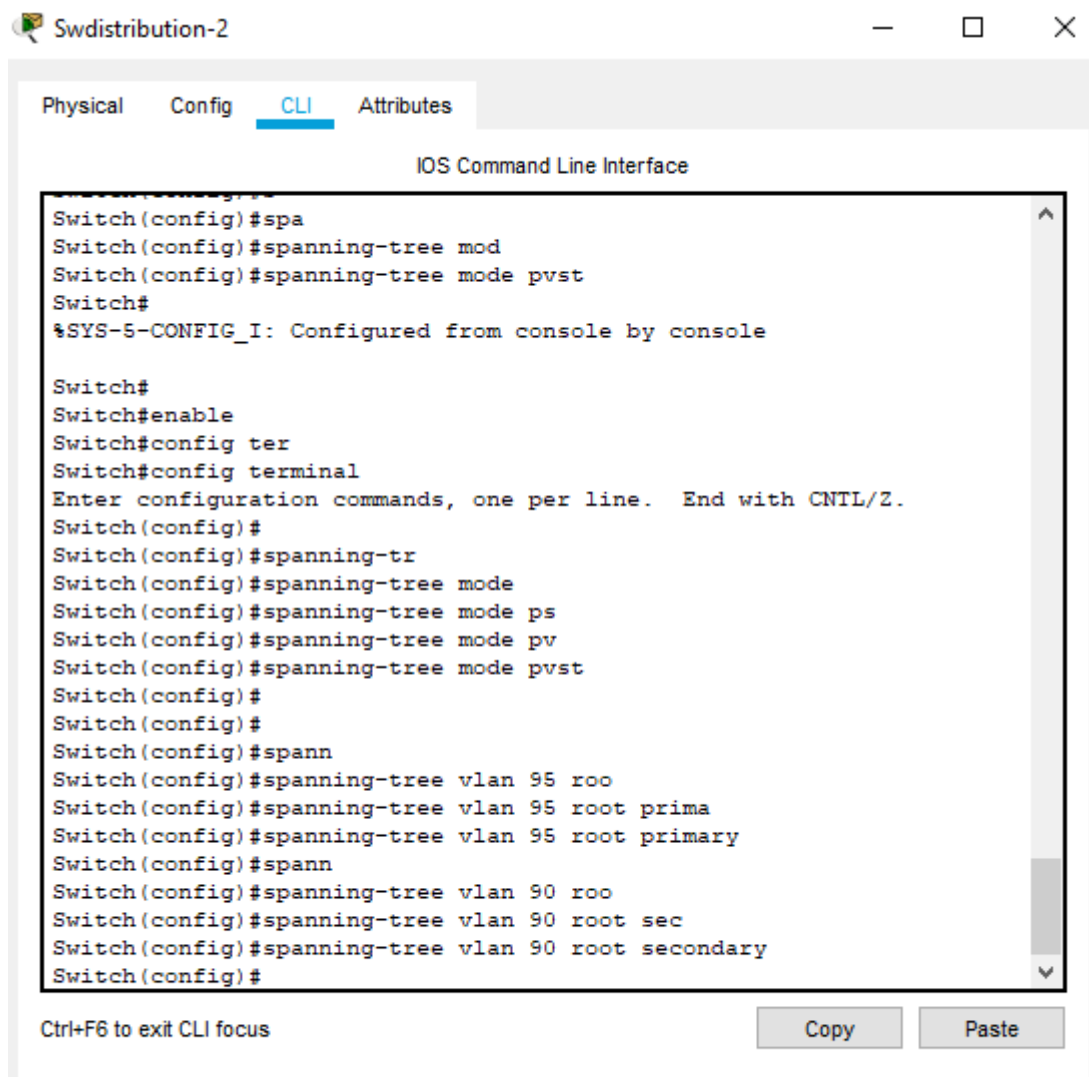
```
Switch>spanning-tree
Translating "spanning-tree"...domain server (255.255.255.255)
% Unknown command or computer name, or unable to find computer
address

Switch>enable config
^
% Invalid input detected at '^' marker.

Switch>enable
Switch#config
Configuring from terminal, memory, or network [terminal]?
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#spa
Switch(config)#spanning-tree mode pvst
Switch(config)#
Switch(config)#
Switch(config)#spa
Switch(config)#spanning-tree vlan 90 prim
Switch(config)#spanning-tree vlan 90 roo
Switch(config)#spanning-tree vlan 90 root prim
Switch(config)#spanning-tree vlan 90 root primary
Switch(config)#span
Switch(config)#spanning-tree vlan 95 roo
Switch(config)#spanning-tree vlan 95 root sec
Switch(config)#spanning-tree vlan 95 root secondary
Switch(config)#
```

**Figura 42 -Configuração da spanning-tree do Swdistribution-1 para eleição do root primary e secondary**

iii) Da mesma forma que o anterior, mas desta vez para o Swdistribution-2.



The screenshot shows a window titled "Swdistribution-2" with a tabbed interface. The "CLI" tab is selected, displaying the "IOS Command Line Interface". The terminal output shows the following commands and responses:

```
Switch(config)#spa
Switch(config)#spanning-tree mod
Switch(config)#spanning-tree mode pvst
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#
Switch#enable
Switch#config ter
Switch#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#
Switch(config)#spanning-tr
Switch(config)#spanning-tree mode
Switch(config)#spanning-tree mode ps
Switch(config)#spanning-tree mode pv
Switch(config)#spanning-tree mode pvst
Switch(config)#
Switch(config)#
Switch(config)#spann
Switch(config)#spanning-tree vlan 95 roo
Switch(config)#spanning-tree vlan 95 root prima
Switch(config)#spanning-tree vlan 95 root primary
Switch(config)#spann
Switch(config)#spanning-tree vlan 90 roo
Switch(config)#spanning-tree vlan 90 root sec
Switch(config)#spanning-tree vlan 90 root secondary
Switch(config)#
```

At the bottom of the window, there is a status bar with the text "Ctrl+F6 to exit CLI focus" and two buttons: "Copy" and "Paste".

**Figura 43 - Configuração spanning-tree do Swdistribution-2 do root primary e secondary**

iv) Para fazer a prune, não foram desativadas nenhuma VLAN em nenhum torço pois poderia vir a ser necessário essa ligação no caso de falhas.

v) Como se pode verificar na figura 44 existem 3 Spanning-trees. Uma da VLAN por omissão, outra da VLAN 90 e da 95.

vi)

```

Switch#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
    Root ID    Priority    32769
              Address    0001.C961.38DD
              Cost      19
              Port      1(FastEthernet0/1)
              Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

    Bridge ID  Priority    32769 (priority 32768 sys-id-ext 1)
              Address    0040.0BEB.E1DE
              Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 20

Interface                Role Sts Cost      Prio.Nbr Type
-----
Fa0/1                    Root FWD 19        128.1   P2p
Fa0/2                    Desg FWD 19        128.2   P2p
Fa0/24                   Desg FWD 19        128.24  P2p

VLAN0090
  Spanning tree enabled protocol ieee
    Root ID    Priority    24666
              Address    0001.C961.38DD
              Cost      19
              Port      1(FastEthernet0/1)
              Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

    Bridge ID  Priority    32858 (priority 32768 sys-id-ext 90)
              Address    0040.0BEB.E1DE
              Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 20

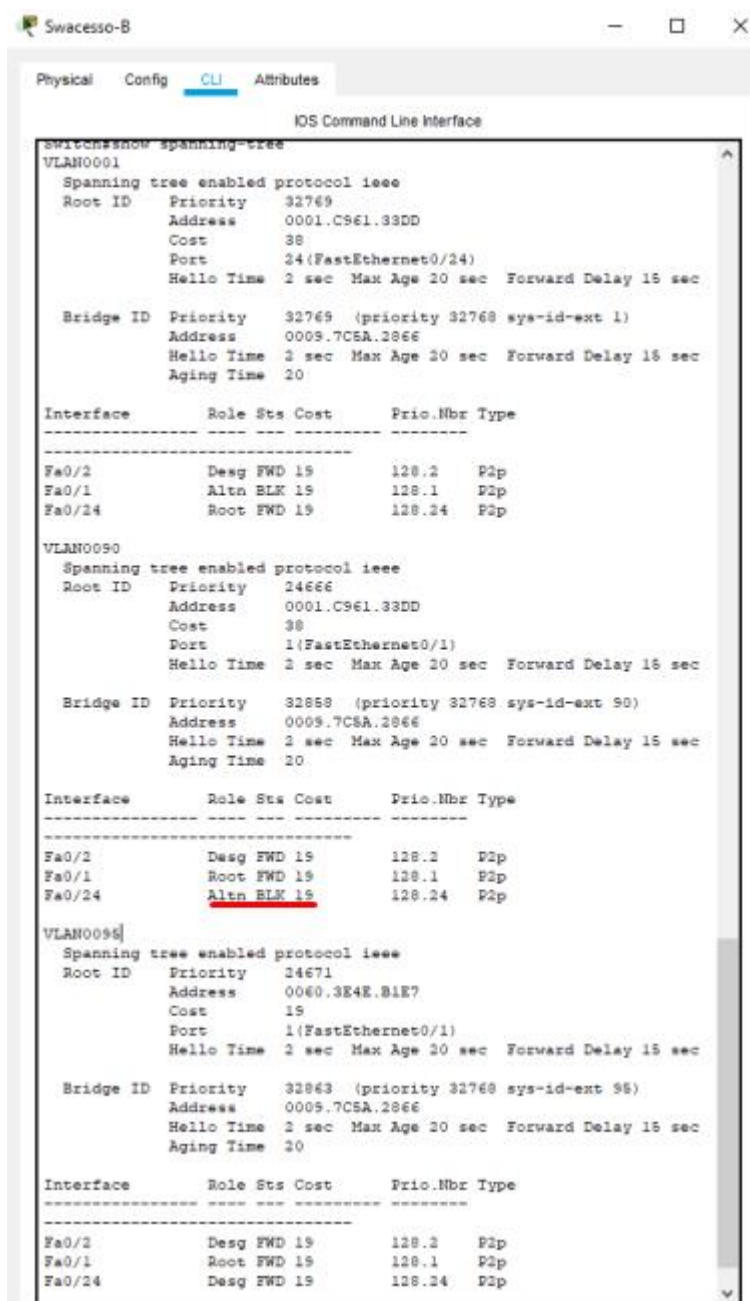
Interface                Role Sts Cost      Prio.Nbr Type
-----
Fa0/1                    Root FWD 19        128.1   P2p
Fa0/2                    Desg FWD 19        128.2   P2p
Fa0/24                   Desg FWD 19        128.24  P2p

VLAN0095
  Spanning tree enabled protocol ieee
    Root ID    Priority    24671
              Address    0040.3E4E.B1E7
              Cost      38
              Port      1(FastEthernet0/1)
              Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec

    Bridge ID  Priority    32863 (priority 32768 sys-id-ext 95)
              Address    0040.0BEB.E1DE
              Hello Time 2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 20

Interface                Role Sts Cost      Prio.Nbr Type
-----
Fa0/1                    Root FWD 19        128.1   P2p
Fa0/2                    Desg FWD 19        128.2   P2p
Fa0/24                   Alert BLK 19        128.24  P2p
  
```

Figura 44 - Portas bloqueadas no swaccess-A



```

Swaccess-B
Physical Config CLI Attributes
IOS Command Line Interface
switch#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
            Address    0001.C961.33DD
            Cost        38
            Port        24(FastEthernet0/24)
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769 (priority 32768 sys-id-ext 1)
            Address    0009.7C5A.2866
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
            Aging Time  20

Interface                Role Sts Cost      Prio.Nbr Type
-----
Fa0/2                    Desg FWD 19      128.2    P2p
Fa0/1                    Altn BLK 19      128.1    P2p
Fa0/24                   Root FWD 19      128.24   P2p

VLAN0090
  Spanning tree enabled protocol ieee
  Root ID    Priority    24666
            Address    0001.C961.33DD
            Cost        38
            Port        1(FastEthernet0/1)
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32858 (priority 32768 sys-id-ext 90)
            Address    0009.7C5A.2866
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
            Aging Time  20

Interface                Role Sts Cost      Prio.Nbr Type
-----
Fa0/2                    Desg FWD 19      128.2    P2p
Fa0/1                    Root FWD 19      128.1    P2p
Fa0/24                   Altn BLK 19      128.24   P2p

VLAN0096
  Spanning tree enabled protocol ieee
  Root ID    Priority    34671
            Address    0060.3E4E.81E7
            Cost        19
            Port        1(FastEthernet0/1)
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32863 (priority 32768 sys-id-ext 96)
            Address    0009.7C5A.2866
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
            Aging Time  20

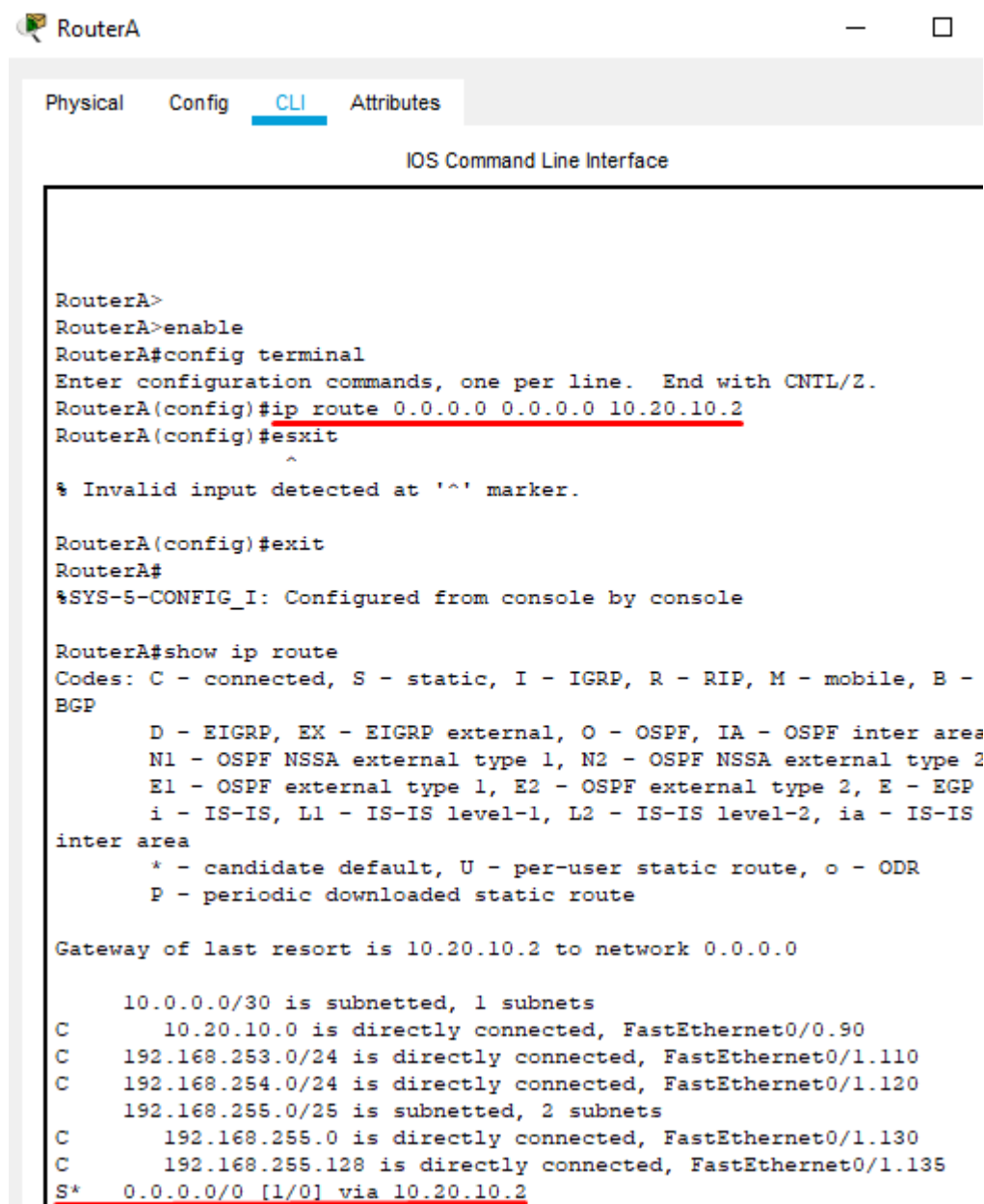
Interface                Role Sts Cost      Prio.Nbr Type
-----
Fa0/2                    Desg FWD 19      128.2    P2p
Fa0/1                    Root FWD 19      128.1    P2p
Fa0/24                   Desg FWD 19      128.24   P2p

```

Figura 45 - Portas bloqueadas no swaccess-B

## Tarefa 6

a) Para configurar as rotas estáticas foi necessário meter em ambos os routers, onde o *next-hop* é o endereço da porta do router para onde se quer enviar. Foram testadas diversas alternativas em vez do endereço 0.0.0.0, contudo nenhuma com sucesso. O objetivo desta metodologia é forçar o router a enviar os pacotes sempre para uma determinada rota para um determinado endereço IP.



```

RouterA
Physical Config CLI Attributes
IOS Command Line Interface

RouterA>
RouterA>enable
RouterA#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
RouterA(config)#ip route 0.0.0.0 0.0.0.0 10.20.10.2
RouterA(config)#exit
^
% Invalid input detected at '^' marker.

RouterA(config)#exit
RouterA#
%SYS-5-CONFIG_I: Configured from console by console

RouterA#show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

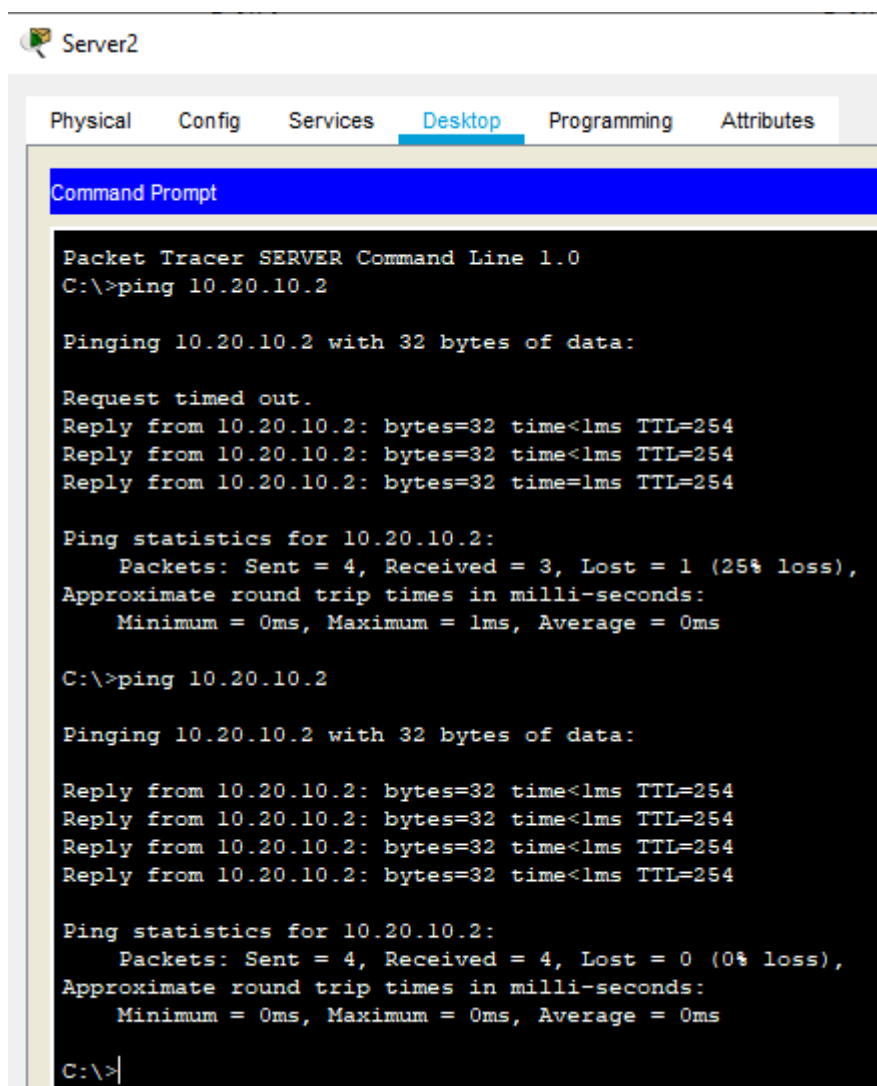
Gateway of last resort is 10.20.10.2 to network 0.0.0.0

    10.0.0.0/30 is subnetted, 1 subnets
C      10.20.10.0 is directly connected, FastEthernet0/0.90
C    192.168.253.0/24 is directly connected, FastEthernet0/1.110
C    192.168.254.0/24 is directly connected, FastEthernet0/1.120
    192.168.255.0/25 is subnetted, 2 subnets
C      192.168.255.0 is directly connected, FastEthernet0/1.130
C    192.168.255.128 is directly connected, FastEthernet0/1.135
S*    0.0.0.0/0 [1/0] via 10.20.10.2
  
```

Figura 46 - Configuração da rota estática do routerA até router1

b) Sim, os pcs conseguem pingar o seu router do ISP, porque já existe uma rota estática que permite que o router envie pacotes para fora e, desta forma é possível “pingar” com o primeiro.

c) Os pings resultantes foram os que se seguem:



```
Server2
Physical Config Services Desktop Programming Attributes
Command Prompt
Packet Tracer SERVER Command Line 1.0
C:\>ping 10.20.10.2

Pinging 10.20.10.2 with 32 bytes of data:

Request timed out.
Reply from 10.20.10.2: bytes=32 time<1ms TTL=254
Reply from 10.20.10.2: bytes=32 time<1ms TTL=254
Reply from 10.20.10.2: bytes=32 time=1ms TTL=254

Ping statistics for 10.20.10.2:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 10.20.10.2

Pinging 10.20.10.2 with 32 bytes of data:

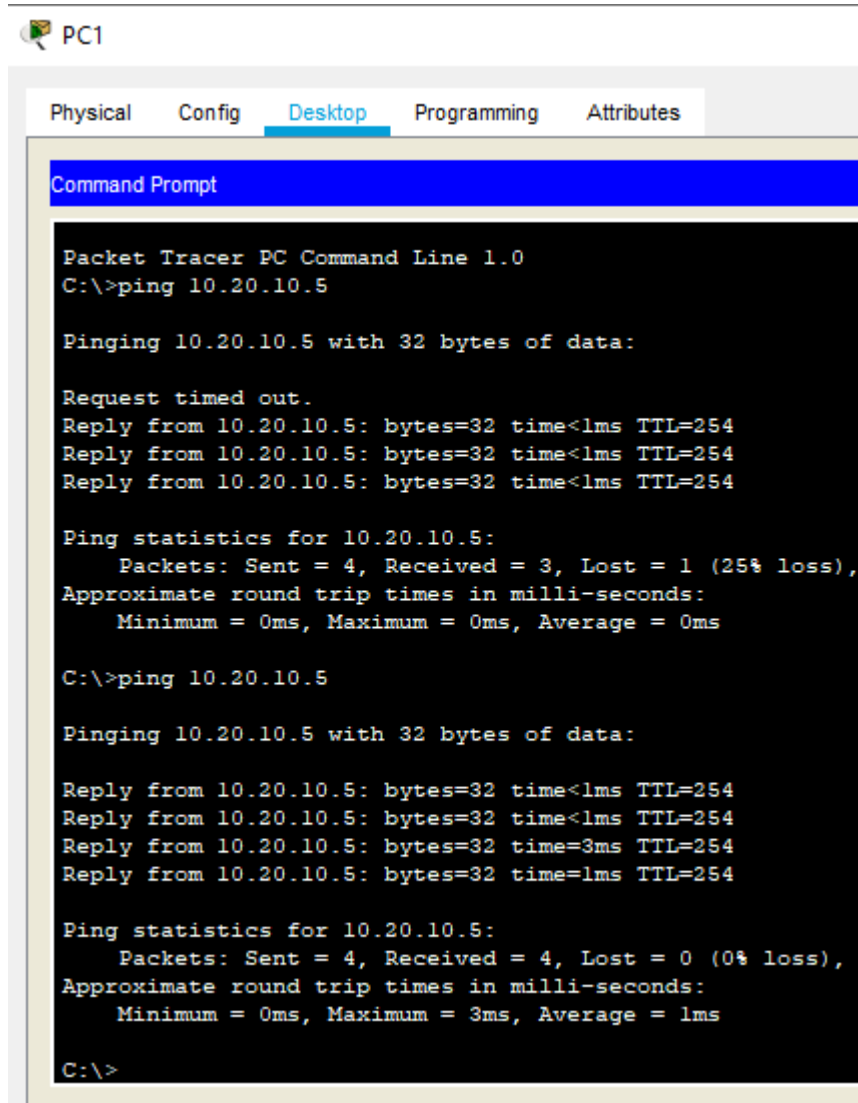
Reply from 10.20.10.2: bytes=32 time<1ms TTL=254
Reply from 10.20.10.2: bytes=32 time<1ms TTL=254
Reply from 10.20.10.2: bytes=32 time<1ms TTL=254
Reply from 10.20.10.2: bytes=32 time<1ms TTL=254

Ping statistics for 10.20.10.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>|
```

Figura 47 - ping server2 - router1





The screenshot shows the Packet Tracer interface for PC1. The 'Desktop' tab is selected, displaying a 'Command Prompt' window. The window title is 'Packet Tracer PC Command Line 1.0'. The user has entered the command 'C:\>ping 10.20.10.5'. The output shows a failed ping attempt with a 'Request timed out.' message, followed by three successful replies from 10.20.10.5 with 32 bytes of data, each taking less than 1ms and having a TTL of 254. The ping statistics for 10.20.10.5 show 4 packets sent, 3 received, and 1 lost (25% loss), with approximate round trip times in milliseconds: Minimum = 0ms, Maximum = 0ms, Average = 0ms. The user has entered the command 'C:\>ping 10.20.10.5' again. The output shows four successful replies from 10.20.10.5 with 32 bytes of data, each taking less than 1ms and having a TTL of 254. The ping statistics for 10.20.10.5 show 4 packets sent, 4 received, and 0 lost (0% loss), with approximate round trip times in milliseconds: Minimum = 0ms, Maximum = 3ms, Average = 1ms. The prompt 'C:\>' is visible at the bottom of the window.

```
Packet Tracer PC Command Line 1.0
C:\>ping 10.20.10.5

Pinging 10.20.10.5 with 32 bytes of data:

Request timed out.
Reply from 10.20.10.5: bytes=32 time<1ms TTL=254
Reply from 10.20.10.5: bytes=32 time<1ms TTL=254
Reply from 10.20.10.5: bytes=32 time<1ms TTL=254

Ping statistics for 10.20.10.5:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 10.20.10.5

Pinging 10.20.10.5 with 32 bytes of data:

Reply from 10.20.10.5: bytes=32 time<1ms TTL=254
Reply from 10.20.10.5: bytes=32 time<1ms TTL=254
Reply from 10.20.10.5: bytes=32 time=3ms TTL=254
Reply from 10.20.10.5: bytes=32 time=1ms TTL=254

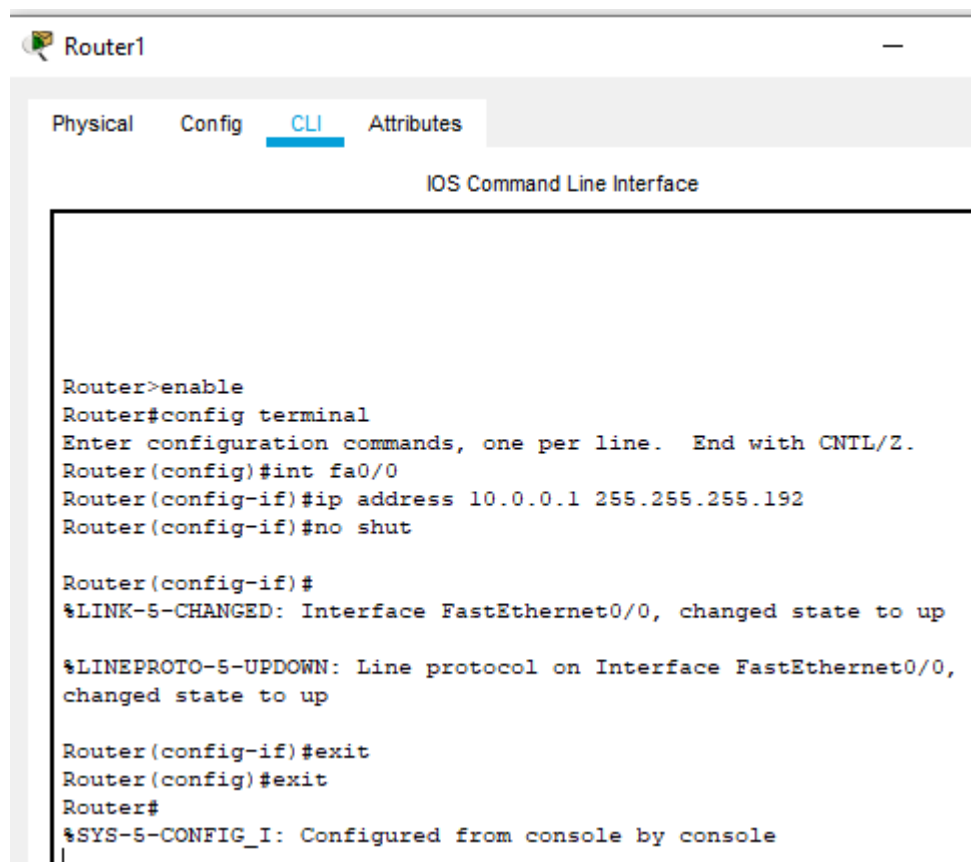
Ping statistics for 10.20.10.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 3ms, Average = 1ms

C:\>
```

Figura 48 - ping pc1 - router3

## Tarefa 7

b) Para configurar as interfaces foi feito o que se segue:



```
Router1
Physical Config CLI Attributes
IOS Command Line Interface

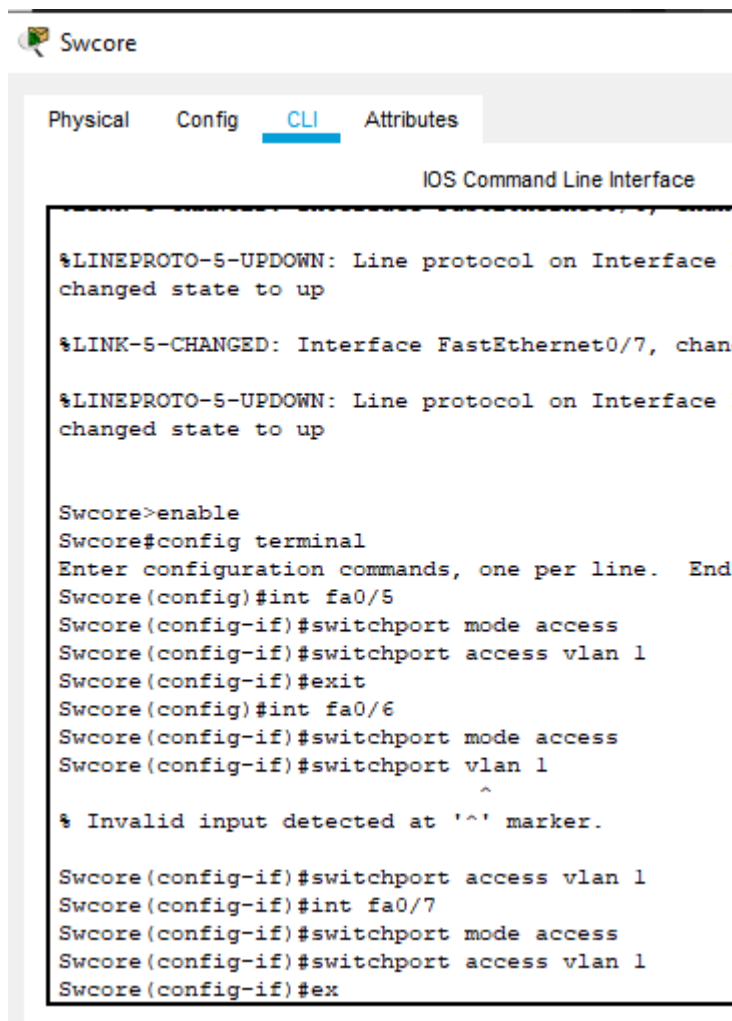
Router>enable
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip address 10.0.0.1 255.255.255.192
Router(config-if)#no shut

Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up

Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
```

Figura 49 - Configuração da rede no router1

c) Sim é necessário configurar tudo para funcionar na VLAN1 para que haja comunicação entre todos os routers.



```
Swcore
Physical Config CLI Attributes
IOS Command Line Interface

%LINEPROTO-5-UPDOWN: Line protocol on Interface
changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/7, chan

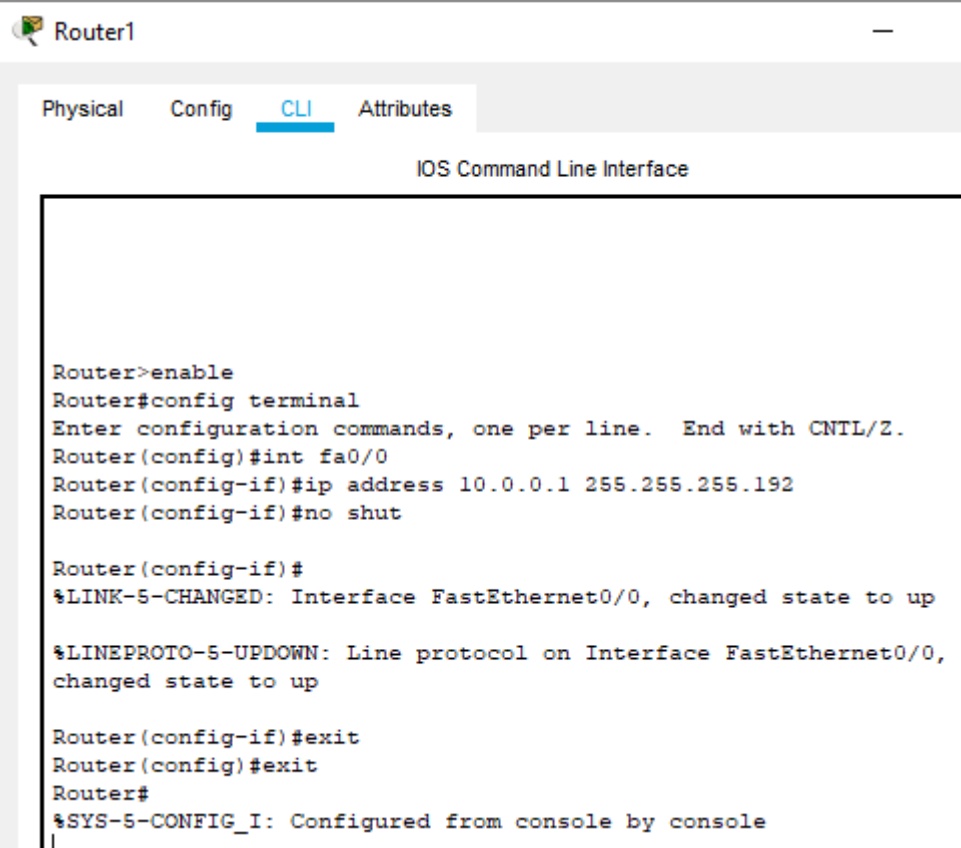
%LINEPROTO-5-UPDOWN: Line protocol on Interface
changed state to up

Swcore>enable
Swcore#config terminal
Enter configuration commands, one per line.  End
Swcore(config)#int fa0/5
Swcore(config-if)#switchport mode access
Swcore(config-if)#switchport access vlan 1
Swcore(config-if)#exit
Swcore(config)#int fa0/6
Swcore(config-if)#switchport mode access
Swcore(config-if)#switchport vlan 1
Swcore(config-if)#switchport access vlan 1
Swcore(config-if)#int fa0/7
Swcore(config-if)#switchport mode access
Swcore(config-if)#switchport access vlan 1
Swcore(config-if)#ex
```

Figura 50 - Configuração do Swcore

d) Configuração do RIP no core:

ii) Primeiramente foi necessário configurar os endereços IP dos routers vizinhos (virados para a rede do router 2), neste caso o que corre o protocolo RIP.



```
Router1
Physical Config CLI Attributes
IOS Command Line Interface

Router>enable
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip address 10.0.0.1 255.255.255.192
Router(config-if)#no shut

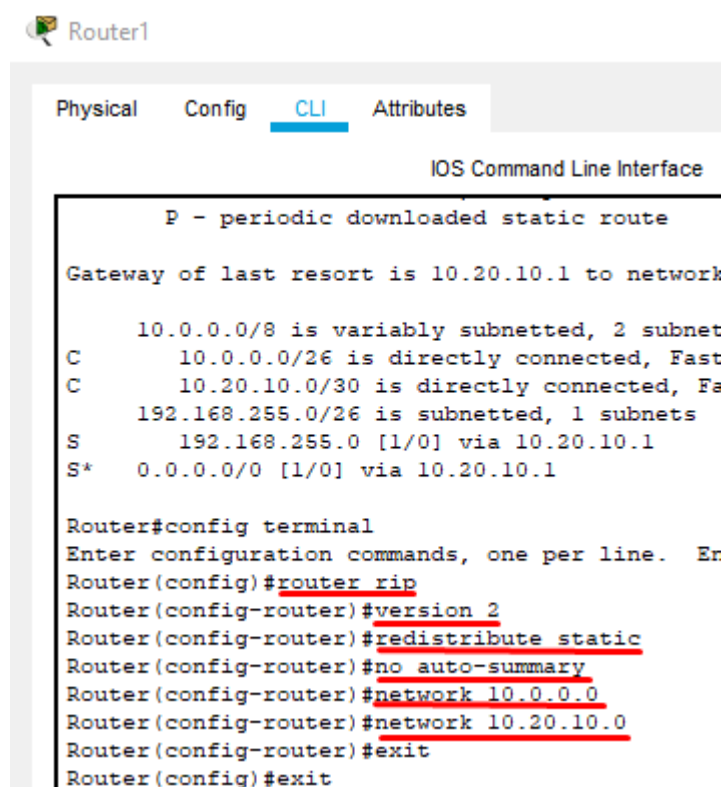
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up

Router(config-if)#exit
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console
|
```

Figura 51 - Configuração dos endereços IP do router1

iii) Para configurar as rotas estáticas serem propagadas foi necessário utilizar o comando *redistribute static*.



```
Router1
Physical Config CLI Attributes
IOS Command Line Interface

P - periodic downloaded static route
Gateway of last resort is 10.20.10.1 to network

  10.0.0.0/8 is variably subnetted, 2 subnets
C    10.0.0.0/26 is directly connected, FastEthernet0/0
C    10.20.10.0/30 is directly connected, FastEthernet0/24
S    192.168.255.0/26 is subnetted, 1 subnets
S    192.168.255.0 [1/0] via 10.20.10.1
S*   0.0.0.0/0 [1/0] via 10.20.10.1

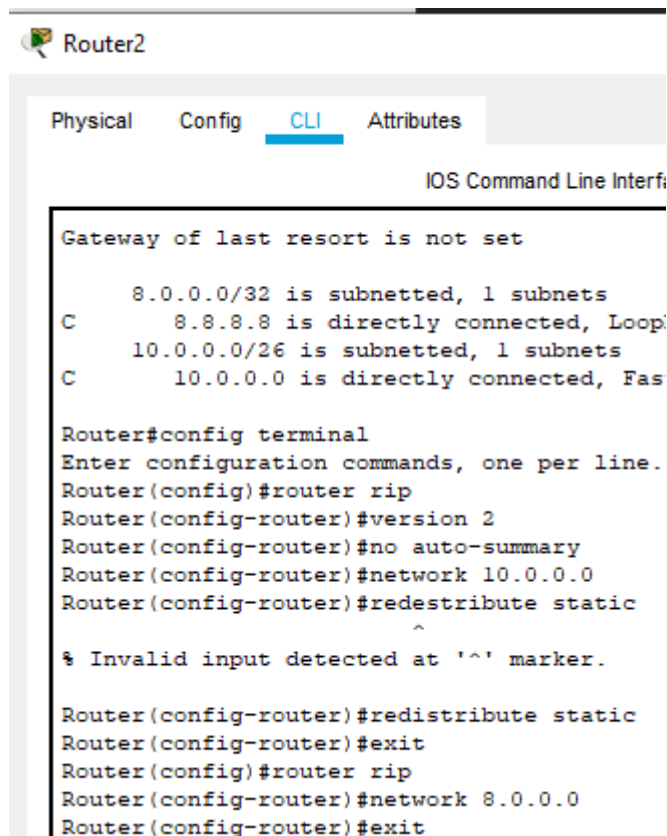
Router#config terminal
Enter configuration commands, one per line. End with Ctrl-Z to exit.
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#redistribute static
Router(config-router)#no auto-summary
Router(config-router)#network 10.0.0.0
Router(config-router)#network 10.20.10.0
Router(config-router)#exit
Router(config)#exit
```

Figura 52 - Configurações do protocolo RIP no router1

iv) O router R2 não propaga automaticamente a rota por omissão através do RIP. No entanto, é necessário que estas sejam anunciadas, porque sem o anúncio das redes que existem o RIP não obtém e não transmite essa informação.



vi) Sim é necessário anunciar a rede 8.8.8.8 porque a rota não é estática e os outros participantes na topologia não sabem da existência dessa rede.



```
Router2
Physical Config CLI Attributes
IOS Command Line Interface

Gateway of last resort is not set

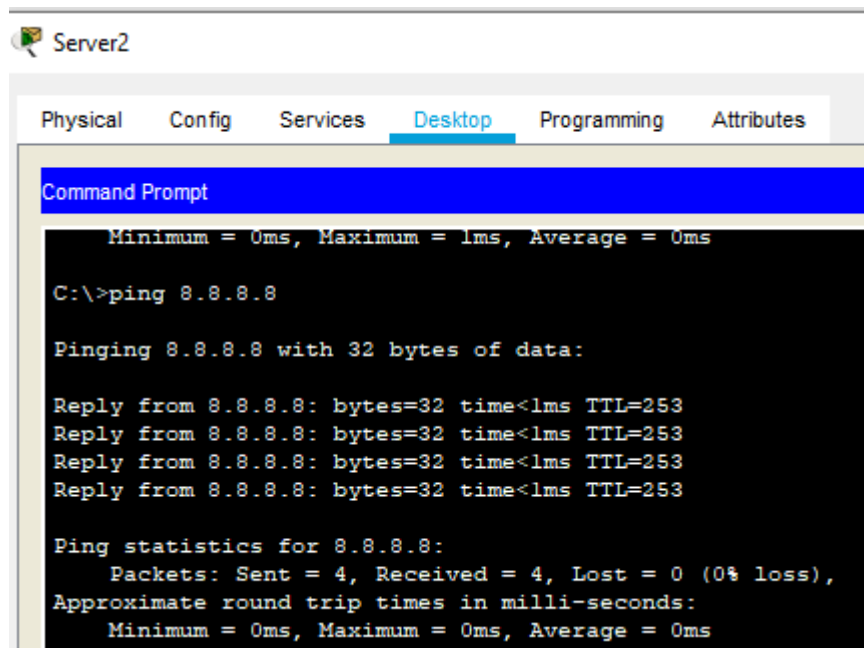
      8.0.0.0/32 is subnetted, 1 subnets
C       8.8.8.8 is directly connected, Loopback0
      10.0.0.0/26 is subnetted, 1 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0

Router#config terminal
Enter configuration commands, one per line.
Router(config)#router rip
Router(config-router)#version 2
Router(config-router)#no auto-summary
Router(config-router)#network 10.0.0.0
Router(config-router)#redistribute static
                        ^
% Invalid input detected at '^' marker.

Router(config-router)#redistribute static
Router(config-router)#exit
Router(config)#router rip
Router(config-router)#network 8.0.0.0
Router(config-router)#exit
```

Figura 54 - Configuração do RIP no router2

vii)



The screenshot shows a Command Prompt window titled "Server2" with the "Desktop" tab selected. The command prompt displays the output of a ping command to 8.8.8.8. The output shows four successful replies with a time of less than 1ms and a TTL of 253. The ping statistics show 4 packets sent, 4 received, and 0% loss.

```
Minimum = 0ms, Maximum = 1ms, Average = 0ms

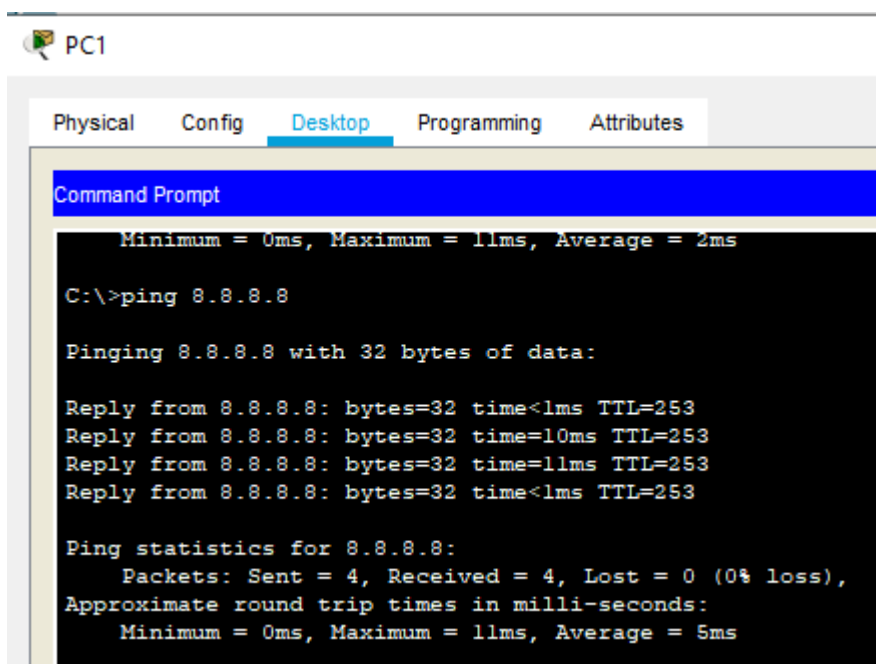
C:\>ping 8.8.8.8

Pinging 8.8.8.8 with 32 bytes of data:

Reply from 8.8.8.8: bytes=32 time<1ms TTL=253
Reply from 8.8.8.8: bytes=32 time<1ms TTL=253
Reply from 8.8.8.8: bytes=32 time<1ms TTL=253
Reply from 8.8.8.8: bytes=32 time<1ms TTL=253

Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Figura 55 - ping server2 para o 8.8.8.8



The screenshot shows a Command Prompt window titled "PC1" with the "Desktop" tab selected. The command prompt displays the output of a ping command to 8.8.8.8. The output shows four successful replies with times of less than 1ms, 10ms, 11ms, and less than 1ms, and a TTL of 253. The ping statistics show 4 packets sent, 4 received, and 0% loss.

```
Minimum = 0ms, Maximum = 11ms, Average = 2ms

C:\>ping 8.8.8.8

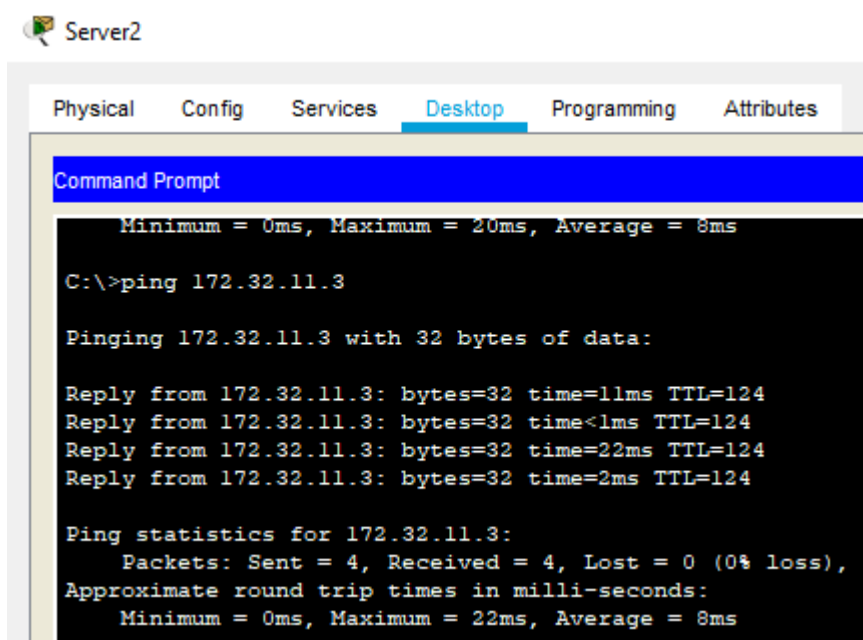
Pinging 8.8.8.8 with 32 bytes of data:

Reply from 8.8.8.8: bytes=32 time<1ms TTL=253
Reply from 8.8.8.8: bytes=32 time=10ms TTL=253
Reply from 8.8.8.8: bytes=32 time=11ms TTL=253
Reply from 8.8.8.8: bytes=32 time<1ms TTL=253

Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 11ms, Average = 5ms
```

Figura 56 - ping pc1 para o 8.8.8.8





The screenshot shows a Windows Server 2008 R2 desktop environment. The taskbar at the top includes icons for 'Server2' and several open applications. The 'Server2' window is active, displaying a 'Command Prompt' window. The Command Prompt shows the execution of the command 'C:\>ping 172.32.11.3'. The output indicates a successful ping with 32 bytes of data. The ping statistics for 172.32.11.3 are as follows:

```
Minimum = 0ms, Maximum = 20ms, Average = 8ms

C:\>ping 172.32.11.3

Pinging 172.32.11.3 with 32 bytes of data:

Reply from 172.32.11.3: bytes=32 time=11ms TTL=124
Reply from 172.32.11.3: bytes=32 time<1ms TTL=124
Reply from 172.32.11.3: bytes=32 time=22ms TTL=124
Reply from 172.32.11.3: bytes=32 time=2ms TTL=124

Ping statistics for 172.32.11.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 22ms, Average = 8ms
```

Figura 57 - ping server2 para o pc1

### 3. Conclusões

Em suma, no presente trabalho o grupo teve oportunidade de aplicar o conhecimento aprendido durante as aulas teóricas. Nomeadamente o conhecimento referente às VLANs, ao Spanning-tree rotas estáticas e também ao RIP.

As VLANs foram utilizadas nomeadamente para fazer a separação de redes dentro do mesmo switch sem a necessidade da utilização de outro switch. As VLANs foram utilizadas nomeadamente para separar redes internas de cada empresa e também fora das empresas para um router específico.

O spanning-tree é utilizado sempre que uma topologia possui switches e possa existir loops dentro da topologia. Por omissão este já vem incorporado dentro dos switches o que o grupo fez foi pequenas alterações a topologia do Spanning-tree e alteração para Rapid Spanning-tree.

As rotas estáticas permitem o encaminhamento de um pacote para um determinado endereço sem a utilização de um protocolo de encaminhamento.

Em relação ao protocolo RIP foi utilizado para a comunicação entre 3 routers no topo da topologia. Onde o objetivo é a propagação de rotas dos routers para os diferentes routers, essa propagação é feita através do anúncio das redes que estão conectadas.

Os resultados obtidos foram os esperados onde a topologia da empresa A e B comunica com a internet simulada pelo endereço IP 8.8.8.8 e também existe comunicação entre a empresa A e a empresa B. Desta forma a topologia ficou a comunicar como era suposto.