Faculdade de Engenharia da Universidade do Porto

Redes de Computadores

2º laboratory work of RCOM

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Summary

This work was carried out within the scope of the RCOM curricular unit and aims to implement a download program using FTP and the configuration of a computer network. In this project we use the material taught in theoretical classes to implement the download program and to configure the network more proficiently.

Summary

The main aim of this project was to develop and test a download program using FTP of the guide and configuring a computer network while following the specifications. This report is split in several sections:

* **Download program**: A brief explanation of the FTP download program
* **Program Code Structure**
* **Tests and Results**
* **Configuration and network analysis**
* **Configuring an IP network**
* **Implementing two bridges**
* **Configuring a router in Linux**
* **Configure a commercial Router and implement NAT**
* **DNS**
* **TCP connections**

FTP Downloader

The aim of this project was to develop and test a download program using FTP according to the prerequisites established in the on the guide and following the norms RFC959 and RFC1738.

Uma imagem com texto, captura de ecrã

Descrição gerada automaticamenteTo run the project first we will need to compile the ftpdownload.c and run it as ./ftpdownload <ftp://rcom:rcom@netlab1.fe.up.pt/pipe.txt> or as ./ftpdownload [ftp:// netlab1.fe.up.pt/pipe.txt](ftp://rcom:rcom@netlab1.fe.up.pt/pipe.txt) because the default pass and user are both rcom receiving this file.

Now talking more about the code we separated the code in several auxiliary fucntions such as parse\_ftp\_url(argv[1], &result) which returns the actual ip of the server after using DNS to translate the hostname to its ip and also returns the path to the file and filename.

After it parses the the url it will open the first socket with the ip translated and on the port 21 because is the default port, in which will be exchanged control information such as authentication, closing, seting pasv mode and selecting the file to download also its here that will be given the port number for the second socket.

Now during Authentication will be given the Username and password if the response is not what is expended will be returned error.

After authentication we will set the mode as passive and create another socket on the ip and socket given with the function passive(socket, &port,ip).

Now after sucessfuly conecting to the second socket, on the first socket we will ask for the file to transferred on the function request\_file(socket,result.path)

After sucessfuly requesting the file the get\_file(socket2,result.filename) which will download the file through the second socket.

After downloading the file the connection will be closed with the fucntion close\_connec(socket)

Configuration and analysis of the network

Experience 1 – Configuring an Ip network

The aim of the experiment 1 is to set up two IP addresses for both Tux 24 and Tux 23 while connected in the same switch and to analyse how the connection behaves when removing from the ARP tables the entries of the configured IPs.

We started by connecting tux 23 and 24 to the switch and configuring each ones IPs by using ifconfig command. The MAC addresses of both computers could be seen in the ARP tables after pinging each other.

Uma imagem com texto, captura de ecrã, Tipo de letra, número

Descrição gerada automaticamente

Now analysing the logs of the ping exchange of ARP packets as result of the ping. the ARP (Address Resolution Protocol) is a communication protocol used in computer networks to map an IP address (network layer) to a physical MAC (link layer) address (Layer 2). The ARP packets are a type of network packet used in the ARP process to discover and map the hardware (MAC) address of a device based on its IP address within a local network now we observed two types of the arp packet one of them broadcasting two ip addresses being one the destination and the other the origin, when the computer who has the destination ip sends as reply an arp packet containing his own MAC address, that’s when this interaction saves both Ips and Mac addresses in the ARP table. When removing the entries of the ARP table what we experience is precisely this.

Questions:

1. What are the commands required to configure this experience?

On appendix 2.1

1. What are the ARP packets and what are they used for?

The ARP (Address Resolution Protocol) packets are a type of network packet used in the ARP process to discover and map the hardware (MAC) address of a device based on its IP address within a local network.

1. What are the MAC and IP addresses of the ARP packets and why

The ip and mac addresses of the ping packets are those of the communicating machines

1. What does the ping command generate?

If that computer doesn’t have its MAC address it will send a ARP packet broadcast in search of the machine that has that ip waiting for the ip when received will send ICMP packets

1. What are the MAC and IP addresses of the ping packets?

The IP and MAC addresses used in ICMP packets are those of the communicating machines: Tux33 and Tux34.

1. How to determine if a receiving Ethernet frame is ARP, IP, ICMP?

The protocol information for each frame is displayed in the "Protocol" column within the Wireshark capture. Typically, the protocol is identified in the initial 2 bytes of the frame, located in the header.

1. How to determine the length of a receiving frame?

In Wireshark, there is a column dedicated to displaying the size, measured in bytes, of the frames. This data is generally found within the header of each respective frame.

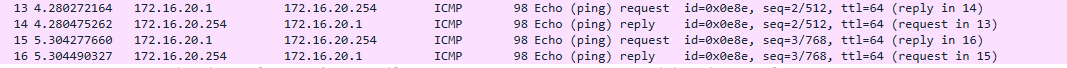
1. What is the loop feedback interface and why is it important?

It represents a virtual interface that remains accessible as long as at least one of the switch's IP interfaces is operational. This feature enables periodic checks to ensure proper configuration of network connections.

Experience 2 – Implementing two bridges

Objective: To create two separate LANs (Local Area Network) inside the same switch one connecting tux 23 and tux24 and other with only Tux 22, using two different bridges

We started by redoing everything from experience 1 because we needed to configure the ip of each separate Tux. Then as explained in the Appendix 2.2. we accessed the switch console to create the two bridges then removed the ports which belonged to the tux22, tux23 and tux24 from the default bridge so we could isolate them then adding them each to the designated bridge.



Now about the analysis of the experience when pinging tux 24 from tux 23 we got response but when pinging tux 22 we didn t got response. Same when broadcasting from tux 23 we got response from tux 24 only as when doing broadcast from 22 we got no response

Question:

1. What are the commands required to configure this experience?

Appendix 2.2

1. How many broadcast domains are there? How can you conclude it from the logs?

There are two upon analysing the logs from the broadcast ping from tux 23 we saw reply from tux24 but not from tux22

 When analysing the ping broadcast from tux22 we saw no reply

Experience 3 – Configure a Router in Linux

Objective: To transform tux 24 in a router between two different LANs

To achive this configuration we redo the configuration of the experience 2 then as explained in the appendix 2.3., the eth1 of tux 24 was configured for the IP 172.16.21.253/24. Afterwards we removed the port of the switch that was connected to the th1 of tux 24 from the default bridge and added to the bridge21, right after we proceeded to disable ICMP echo-ignore-broadcast and enable IP forwarding, afterwards we we would create a route on tux 22 and tus24 so that if they want to send packets to each other they would send instead to tux 24 which then would send to the correct tux that way tux24 would be a router redirecting the packets from one LAN to the other.

Questions:

1. What are the commands required to configure this experience?

Check appendix 2.3.

1. What routes are there in the tuxes? What are their meaning?

Tux 24 has a route that redirects packet to tux22 instead to tux 24 and tux22 and a route that redirects packet to tux23 instead to tux24, because tux24 is the only tux can reach both tux23 and tux22 that way it will redirect the packets to the right tux

1. What information does an entry of the forwarding table contain?

Every entry in the forwarding table includes both the destination address and the corresponding gateway.

1. What ARP messages, and associated MAC addresses, are observed and why?

When pinging from Tux 23 to Tux 22, the ARP messages received include the MAC addresses of Tux 23 and Tux 24, despite the ping originating from Tux 23 to Tux 22. This occurs because Tux 23 is unaware of the address for Tux 22, it only knows the gateway address (Tux 24), which in turn redirects the communication to Tux 22.

1. What ICMP packets are observed and why?

The ICMP come in different types, including "request" and " reply." Here's an example from the logs illustrating ICMP activity: the "request" originates from the machine running the ping command (e.g., Tux 23 with IP 172.16.20.1 and Tux 22 with IP 172.16.21.1), while the corresponding "reply" is generated by the machine being pinged (Tux 22) in response to the machine that initiated the ping (Tux 23).

1. What are the IP and MAC addresses associated to ICMP packets and why?

The IP and MAC Adresses associated to ICMP packets when i.e. pinging tux22 from tux23 the ip origin contain the ip of tux23 and the ip destination contains the ip of tux22 however the mac address contained in the packet is of the tux24 because is the tux 24 that is going to be the gateway connection the two different tuxes as they are not in the same LAN.

Experience 4 – Configure a Router and Implement NAT

Objective: The Objective of this experience is to configure a commercial router with NAT enabled so that the private network can access the exterior internet.

To achieve that we started by redoing the configuration of the later experience and from there we connected we router eth1 to the swich after configuring the designated ip to the port and that port to the bridge21. Then we connected to the router console and proceeded to configure each ports (ip address add) afterwards in each of the tuxes we created default routes so that each of the tuxes could reach the router and one route that makes both lanes accessible through Tux24.

Questions:

1. How to configure a static route in a commercial router?

By using the command /ip route add dst-address=address gateway=anotheraddress

Where the first address is the destination address and the other address is the gateway to which the packet will be sent

1. What are the paths followed by the packets in the experiments carried out and why?

In the step 4 after disabling the ICMP redirects and removing the route from tux22 to tux24 the ping data packets from tux22 to tux23 data packet were redirected through the default route which goes through the router then tux 24 then tux 23, after reenabling the ICMP redirects and adding the route removed earlier the packets won’t go through the router but instead will go directly to tux24 so ICMP always chose the path with less redirects.

1. How to configure NAT in a commercial router?

By using the command /ip firewall nat add chain=srcnat action=masquerade out-interface=ether1

1. What does NAT do?

It translates private IP addresses in an internal network to a public IP address before packets are sent to an external network, and vice versa. Therefore, when a packet is transmitted to an external network, it originates with the public address. Upon receiving a response from the destination computer, the reply is directed to this public address, which is subsequently translated back to the local destination address that initiated the packet. This approach enables a reduction in the utilization of public addresses.

Experience 5 – DNS

Objective: to configure the DNS in Tux22, Tux23 and Tux24 so we can access websites by using their internet address

Questions:

1. How to configure the DNS service in a host?

To do that we will need to change the content of the file /etc/resolv,conf in each tux to “nameserver 172.16.1.1.” in this case the 172.16.1.1 is the IP address of the router in the lab that has access to the external network.

1. What packets are exchanged by DNS and what information is transported?

The packets transported by the network are initially of the DNS type, so that the router identifies and translates the destination IP address.

Experience 6 – TCP connections

Objective: To test the TCP connection with the program we developed in the first part of our project.

To further test it we will compile our program and run it while capturing in tux23, after it ends we will start capturing again but while tux 23 is running the code we will go to tux 22 and start the download to create congestion in the network.

While doing both transfers at the same time the transfer first dipped down then when the tux22 finished, the transfer started recovering as seen in this picture. Uma imagem com texto, file, escrita à mão, diagrama

Descrição gerada automaticamente

As when doing the download from tux23 alone we verified a more stable download as seen in the log below.

Uma imagem com texto, file, escrita à mão, Tipo de letra

Descrição gerada automaticamente

1. How many TCP connections are opened by your FTP application?

There are two tcp connections opened the first one is two authenticate and send commands i.e. set mode pasv, ask the file to be downloaded and disconnect, while the other is to download the file.

1. In what connection is transported the FTP control information?

The FTP control information is sent on the first connection socket

1. What are the phases of a TCP connection?

A TCP connection goes through many phases to establish, maintain and terminate first it goes through the connection Establishment where occurs a three-way handshake with the client sending the SYN waiting to receive from the server SYN-ACK where it sends back ACK and the connection is established. The next phase is the data Transfer phase where data is exchanged followed by the connection termination phase where the connection is closed

1. How does the ARQ TCP mechanism work? What are the relevant TCP fields? What relevant information can be observed in the logs?

Automatic Repeat request (ARQ) is employed to manage retransmissions in the event of network congestion, typically indicated by packet loss. Congestion arises when multiple packets are lost, necessitating a strategy like Additive Increase to send multiple packets simultaneously until congestion occurs.

In the case of packet loss:

Timeout Occurrence: When packet loss is detected due to a timeout, a Multiplicative Decrease occurs. This action reduces the Congestion Window to 1 and then gradually increases it, leveraging the slow start mechanism. The subsequent Additive Increase becomes incremental by one unit.

Three ACKs in a Row: If three consecutive Acknowledgments (ACKs) are received, indicating successful packet delivery, a Multiplicative Decrease is triggered. This reduces the Congestion Window by half, and the subsequent Additive Increase becomes incremental by one unit.

These mechanisms, including Slow Start, Additive Increase, Multiplicative Decrease, and the handling of packet loss scenarios, contribute to TCP's ability to adapt to network conditions and maintain reliable data transmission in congested environments.

The key TCP fields for analysis include the Sequence Number, Acknowledgment Number, ACK flag, and Window Size. When examining logs, the source and destination ports, sequence number, acknowledgment number, window size, and checksum were also seen.

1. How does the TCP congestion control mechanism work? What are the relevant fields. How did the throughput of the data connection evolve along the time? Is it according to the TCP congestion control mechanism?

Every sender assesses the communication capacity by adjusting the number of packets it can send, a process facilitated by the CongestionWindow parameter in the connection. As network congestion intensifies, the CongestionWindow decreases accordingly, and conversely, it expands when congestion levels decrease. This dynamic adjustment ensures that the sender optimally adapts to the varying conditions of the network, enhancing overall efficiency.

1. Is the throughput of a TCP data connections disturbed by the appearance of a second TCP connection? How?

Yes, the data connection is disturbed as the appearance of a second TCP connection will split the bandwidth, slowing both connections as seen in the log

Appendix 2 – Configuration commands

2.1 Experience 1

Tux23: ifconfig eth0 172.16.20.1/24

Tux24: ifconfig eth0 172.16.20.254/24

Tux23: ping 172.16.20.254 (Tux24 responds)

Tux24: ping 172.16.20.1 (Tux23 responds)

Tux23: arp -a

arp -d 172.16.50.254

arp -a

2.2 Experience 2

Tux22:

if config eth0 172.16.21.1/24

Switch console:

/interface bridge add name=bridge20

/interface bridge add name=bridge21

  /interface bridge port remove [find interface=ether3]

  /interface bridge port remove [find interface=ether4]

/interface bridge port remove [find interface=ether5]

/interface bridge port add bridge=bridge21 interface=ether3

/interface bridge port add bridge=bridge20 interface=ether4

/interface bridge port add bridge=bridge20 interface=ether5

/interface bridge port print (to check if the configuration is correct)

Tux 23:

Ping 172.16.20.254/24 (Tux24 get reply)

Ping 172.16.21.1 (Tux22 doesn t get reply)

Ping -b 172.16.20.255

Tux22:

Ping -b 172.16.20.255

2.3 Experience 3

Tux24:

Ifconfig eth1 172.16.21.253/24

Switch console:

/interface bridge port remove [find interface=ether6]

/interface bridge port add bridge=bridge21 interface=ether6

Tux22:

route add -net 172.16.20.1/24 gw 172.16.21.253

Tux23:

route add -net 172.16.21.1/24  gw 172.16.21.254

use route -n in tux22, tux23 and tux24

Tux23:

ping 172.16.20.254

ping 172.16.21.253

ping 172.16.21.1

clean the ARP tables in all tuxes:

Tux22:

arp -d 172.16.21.253

Tux23:

arp -d 172.16.20.254

Tux24:

arp -d 172.16.20.1

arp -d 172.16.21.1

Tux23:

Ping 172.16.21.1 for some seconds

2.4 Experience 4

Using the same configuration of the last experience.

Switch console:

/interface bridge port remove [find interface=ether7]

/interface bridge port add bridge=bridge21 interface=ether7

Router console:

/system reset-configuration (reset configuration)

/ip address add address=172.16.1.29/24 interface=ether1

/ip address add address=172.16.21.254/24 interface=ether2

/ip route add dst-address=172.16.20.0/24 gateway=172.16.21.253

/ip route add dst-address=0.0.0.0/0 gateway=172.16.1.254

Tux23:

Route add default gw 172.16.21.254

Tux23:

Route add default gw 172.16.20.254

Tux24:

Route add default gw 172.16.21.254

Tux23:

Ping 172.16.21.254 (gets reply)

Ping 172.16.20.254 (gets reply)

Ping 172.16.20.1 (gets reply)

Tux22:

sysctl net.ipv4.conf.eth0.accept\_redirects=0

sysctl net.ipv4.conf.all.accept\_redirects=0

route del -net 172.16.50.0 gw 172.16.21.253 netmask 255.255.255.0

ping 172.16.50.1 (gets reply)

traceroute -n 172.16.50.1

route del -net 172.16.50.0 gw 172.16.51.253

netmask 255.255.255.0

ping 172.16.50.1 (gets reply)

sysctl net.ipv4.conf.eth0.accept\_redirects=1

sysctl net.ipv4.conf.all.accept\_redirects=1

Tux23:

Ping 172.16.1.254 (gets reply)

Router console:

/ip firewall nat disable 0

Tux23:

Ping 172.16.1.254 (does not get reply)

* 1. Experience 5

From tux 22,tux23 and tux24

Ping google.com (replies after configuring DNS)

* 1. Experience 6

gcc ftpdownload.c -o download

tux23:

./download ./download <ftp://rcom:rcom@netlab1.fe.up.pt/files/crab.mp4>

Then run on tux23 and on tux 22 while still running

Appendix 3 – Experiences logs

3.1 Experience 1

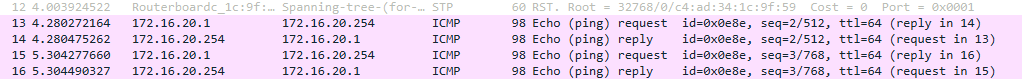
Pinging Tux23 to tux24

Uma imagem com texto, captura de ecrã, Tipo de letra, número

Descrição gerada automaticamente

3.2 Experience 2

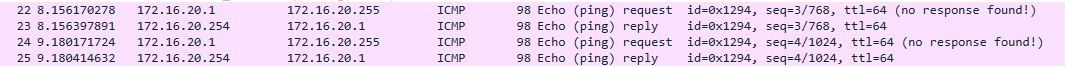
3.2.1 Ping tux23 to tux24



3.2.2. ping broadcast from tux22



3.2.3 ping broadcast from tux23



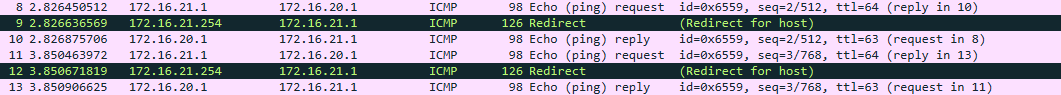
3.3 Experience 3

3.3.1 pinging tux22 from tux23



3.4 Experience 4

3.4.1 pinging tux 23 from tux 22 while being redirected by the router



3.6 Experience 6

Uma imagem com texto, captura de ecrã, Tipo de letra, documento

Descrição gerada automaticamente3.6.1 start of the FTP transfer

3.6.2 end of the ftp file transfer

Uma imagem com texto, Tipo de letra, número, file

Descrição gerada automaticamente