REDES DE COMUNICAÇÕES 1

Objectives

- Study of UDP and TCP transport protocols.
- Service deployment and study of TFTP, FTP, DNS; and HTTP.

Duration

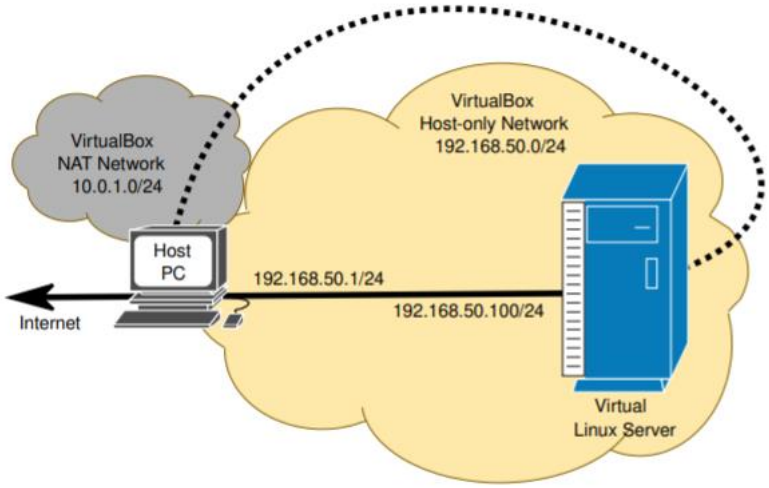
- 2 weeks

VirtualBox Virtual Machines

Install VirtualBox, start it and import a *.OVA appliance (File→ Import Appliance).

IPv4 Network Services

Using a Virtual Box Linux Server Virtual Machine (VM), create a Host-only network to VirtualBox (File→ Host Network Manager...→ Create). Configure the respective IPv4 network according to the diagram below (host IPv4 address 192.168.50.1/24), and disable the DHCP server.
In the virtual server network settings, activate and connect one virtual network adapter connected to the NAT network (to provide Internet access through the host machine), and a second one to the new Host-only network (you may use the default IPv4 network prefix).



Start the Virtual Linux Server, start a terminal, and verify the network connections:

```
ip link                          #shows active interfaces
ip addr                          #shows all interfaces
```

Two Ethernet (en) interfaces must be active. One for the NAT network, and another for the Host-only network. The NAT network should acquire the IPv4 address (and gateway) automatically.
After boot, the interface with IPv4 address should be the NAT network connection, and the one without IPv4 address in the Host-only connection. Identify each interface name (e.g., enp0s8).
The IPv4 address (gateway is not required) for the Host-only network must be configured:

```
sudo ip link set enp0s8 up          #activates eth interface
sudo ip addr add 192.168.50.100/24 dev enp0s8   #configures
IPv4 address
```

Test the server connectivity with the Internet and Host PC (192.168.50.1).
Note: Windows Host PCs' Firewall may be blocking ICMP Echo (ping) request packets.

DNS

1. At the server, verify if the DNS (bind9) service is installed and active with the command:

```
sudo systemctl status bind9
```

To install, run the following commands:

```
sudo apt-get update
sudo apt-get install bind9
```

To start the FTP service and recheck the status of the service (and identify possible errors with *journalctl*):

```
sudo systemctl start bind9
sudo systemctl status bind9
sudo journalctl -xeu bind9
```

2. Assuming that you have the domain ArqRedes.pt, configure your DNS server as master with authority over this domain. Start by creating the zone for the domain by adding to the configuration file /etc/bind/named.conf.local the following definitions:

```
zone "arqredes.pt" in{
   type master;                    //define the zone as master
   file "/etc/bind/db.arqredes.pt";     //file   with   the   domain
records
};
```

Create the file /etc/bind/db.arqredes.pt and add to it the following definitions and DNS records:

```
$TTL  604800
$ORIGIN arqredes.pt.
@     IN    SOA   ns1.arqredes.pt. adm.arqredes.pt. (
                  2           ; Serial
                  604800      ; Refresh
                  86400       ; Retry
                  2419200     ; Expire
                  604800)     ; Negative Cache TTL
      IN    NS    ns1.arqredes.pt.
ns1   IN    A     192.168.50.100
@     IN    A     192.168.50.100
www   IN    A     192.168.50.100
siteA IN    A     192.168.50.100
hostPC      IN    A     192.168.50.1
```

Verify if the file with the zone definitions is correctly constructed:

```
named-checkzone arqredes.pt db.arqredes.pt
```

Restart the DNS server:

```
sudo systemctl restart bind9
```

At the Host PC, define your Virtual Server as main DNS server, start a Wireshark capture in the interface that connects to the server (Host-only adapter), perform the following DNS queries:

```
nslookup arqredes.pt
nslookup www.arqredes.pt
nslookup siteA.arqredes.pt
nslookup hostPC.arqredes.pt
```

Note: To configure the DNS server in Linux edit the file /etc/resolv.conf with the Virtual Server address.

>> Analyze the captured DNS packets.

HTTP

1. At the server, verify if the HTTP (apache2) service is installed and active with the command:

```
sudo systemctl status apache2
```

To install, run the following commands:

```
sudo apt-get update
sudo apt-get install apache2
```

To start the HTTP service and recheck the status of the service (and identify possible errors with *journalctl*):

```
sudo systemctl start apache2
```

```
sudo systemctl status apache2
sudo journalctl -xeu apache2
```

Analyze the content of the apache2 main configuration file (/etc/apache2/apache2.conf). At the Host PC, start a Wireshark capture in the interface that connects to the server (Host-only adapter), and test the HTTP server accessing the following URL (with a browser):

```
http://192.168.50.100
http://arqredes.pt
http://www.arqredes.pt
http://siteA.arqredes.pt
```

>> Based on the captured packets, identify and analyze the TCP sessions (including sequence and acknowledge numbers and flags), and the content of the HTTP packets. Explain how the HTTP server identifies the webpage/data to send to the client.

2. In the apache2 default content folder /var/www/html/, create a new folder named "arqredes.pt-80" (name format is not mandatory, but it is important to maintain consistence, e.g., *domain-port*) to store the webpage associated with the domain arqredes.pt. Inside the new folder create a new HTML file named index.html (default webpage name) with the following content (you may change it):

```
<html>
<body>
<h1>arqredes.pt</h1>
<h2>Porto 80</h2>
</body>
</html>
```

To create a new website at the server, it is required to define a new apache2 Virtual Host. In the folder /etc/apache2/sites-available/ create a new file (named arqredes.pt-80.conf) with the following content:

```
<VirtualHost *:80>
      DocumentRoot /var/www/html/arqredes.pt-80
      ServerName arqredes.pt
</VirtualHost>
```

Enable the new domain/site and restart the HTTP server:

```
sudo a2ensite arqredes.pt-80
sudo systemctl restart apache2
```

Test the HTTP server accessing the following URL (with a browser):

```
http://192.168.50.100
http://arqredes.pt
http://www.arqredes.pt
http://siteA.arqredes.pt
```

>> What do you conclude?

3. At the Virtual Host definition (arqredes.pt-80) add the following directive (below *ServerName*):

```
      ServerAlias www.arqredes.pt
```

Restart the HTTP server:

```
service apache2 restart
```

Test the HTTP server accessing the following URL:

```
http://192.168.50.100
http://arqredes.pt
http://www.arqredes.pt
```

```
http://siteA.arqredes.pt
```
>> What do you conclude?

4. Create a different site/webpage for the subdomain siteA.arqredes.pt.

TFTP

1. At the server, verify if the TFTP service is installed and active with the command:
```
sudo systemctl service atftpd
```
To install, run the following commands:
```
sudo apt-get update
sudo apt-get install atftpd
```
To start the service, first, edit the file /etc/default/atftpd by adding the following line (at the top):
```
USE_INETD=false
```
Then, start the TFTP service and recheck the status of the service (and identify possible errors with *journalctl*):
```
sudo systemctl start atftpd
sudo systemctl status atftpd
sudo journalctl -xeu atftpd
```
Note: If the service activation does not work (active (exited)), this is because there is another service on port 69. Restart the VM and try again.
Note: The TFTP service root folder is /srv/tftp.

2. Verify which IPv4 services are active at the server listing all the UDP open ports and TCP ports in LISTEN state, with the command:
```
netstat -lnutp4
```
Note: UDP port 69 is (by default) the TFTP service assigned UDP port

3. At the server, in the folder (/srv/tftp/), create two files with random content, one with 1500 bytes and another with 1024 bytes,
```
sudo su
cd /srv/tftp/
dd if=/dev/urandom of=file1500 bs=1 count=1500
dd if=/dev/urandom of=file1024 bs=1 count=1024
chown nobody:nogroup *
```
At the Host PC, start a Wireshark capture in the interface that connects to the server (Host-only adapter).
At the Host PC install and run a TFTP client:
(Linux)
Install: `apt install tftp`
Connect the TFTP client to the service and activate binary transference:
```
tftp 192.168.50.100
bin
```
Download the two files form the server:
```
get file1500
get file1024
```
Upload both files to the server:
```
put file1500
put file1024
```
(Windows)
Install: Control Panel→ Programs→ Turn Windows features on and off→ Activate TFTP client.

Download the two files form the server:

```
tftp -i 192.168.50.100 GET file1500
tftp -i 192.168.50.100 GET file1024
```

Upload both files to the server:

```
tftp -i 192.168.50.100 PUT file1500
tftp -i 192.168.50.100 PUT file1024
```

Note: you may need to disable the Windows Firewall.

>>Analyze the sequence of exchanged TFTP packets. Explain the UDP ports chosen to transfer files. Explain why a packet with zero data bytes is transmitted at the end of the 1024 bytes file transference. Explain why some TFTP packets are padded with zeros.

FTP

1. At the server, verify if the FTP service is installed and active with the command:

```
sudo systemctl status vsftpd
```

To install, run the following commands:

```
sudo apt-get update
sudo apt-get install vsftpd
```

To start the FTP service and recheck the status of the service (and identify possible errors with *journalctl*):

```
sudo systemctl start vsftpd
sudo systemctl status vsftpd
sudo journalctl -xeu vsftpd
```

*E*dit the file */etc/vsftpd.conf and uncomment the line "write_enable=YES" to enable write commands.* Restart the service:

```
sudo systemctl restart vsftpd
```

Note: The FTP service maps each user folder as respective root (i.e., for labcom user is /home/labcom/).

2. At the server, in the home folder (/home/labcom/), create one file with 15K bytes:

```
dd if=/dev/urandom of=file15K bs=1k count=15
```

At the Host PC, start a Wireshark capture in the interface that connects to the server (Host-only adapter), start the FTP client and activate the binary mode of transference:

```
ftp 192.168.50.100
bin
```

Dowload file file15 from the server:

```
get file15k
```

Upload the same file to the server:

```
put file15K
```

>> Based on the captured packets, identify and analyze the TCP sessions (including sequence and acknowledge numbers and flags).

>> Analyze the exchanged FTP commands.

Note: Wireshark packet decoding (by default) uses relative TCP sequence numbers, i.e., the first packet TCP sequence number is always shown as zero and all following sequence numbers are adjusted accordingly. In reality, the first sequence number is not zero.

3. Activate the passive FTP transference mode (PASV), and upload the file file15K to the server:

(Linux – at the FTP client prompt)

```
passive
put file15k
```

(Windows)

The FTP command line in Windows does not support the passive mode. Download and install another FTP client. For example: FileZilla: https://filezilla-project.org/ , File→ Network Configuration Wizard…. Note: FTP passive mode is FileZilla's default.
>> Analyze the differences between passive and non-passive TFP transfer modes. In which scenarios is the passive mode essential?

Extra - Connecting a VM to GNS3

Go to GNS3 menu Edit→Preferences→VirtualBox→VirtualBox templates" and create a new VM template based on an existing VirtualBox machine. Add the VM to GNS3 project from the device list.
Some notes:
- To use the VM in GNS3 always start/stop it from within GNS3;
- Before starting the VM from inside GNS3, the VM should be powered off and the network adapter should be configured as "not attached";
- To connect any VM to the Internet stop it in GNS3, configure the network adapter as "NAT" and start it from the VirtualBox Interface;
- To use multiple VM instances, clone the original machine in VirtualBox interface and create a new template in GNS3.