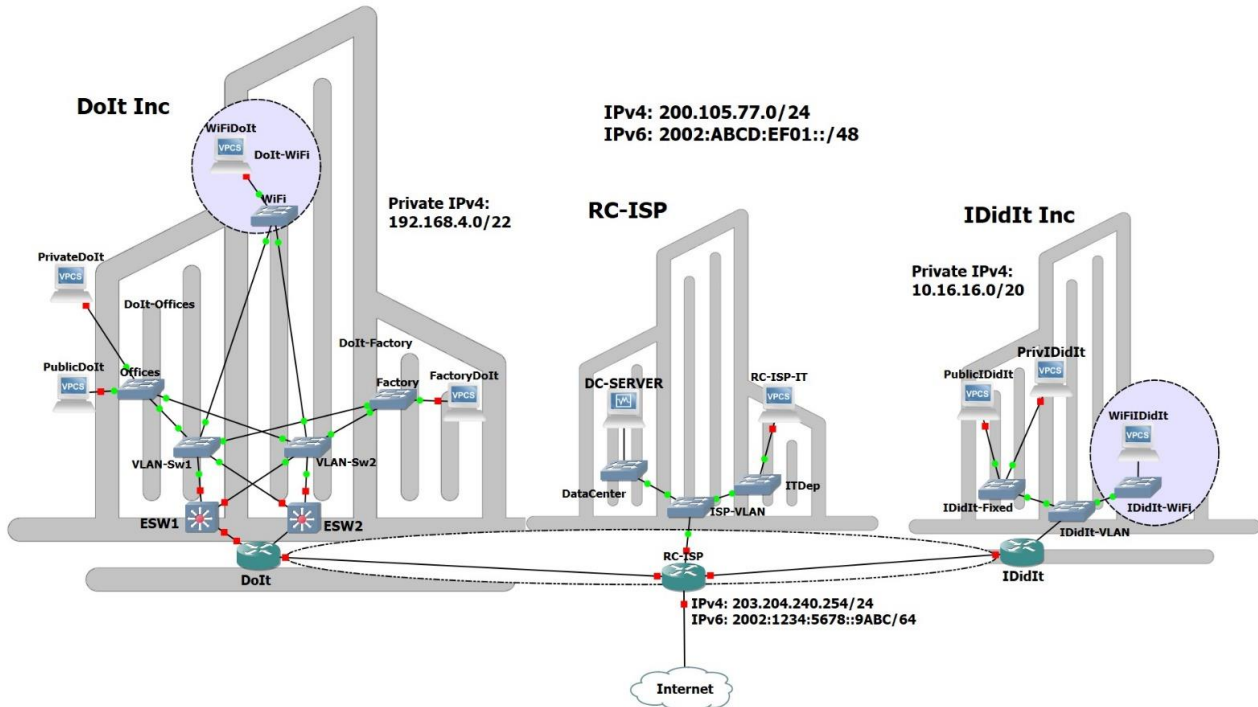Universidade de Aveiro
Licenciatura em Engenharia de Computadores e Informática
Exame Final de Redes de Comunicações 1 – 09 de Janeiro de 2024

Duration: 2:00 hours. No additional reading. Carefully justify all answers.

Consider that you are the manager of a network, RC-ISP, that provides services to 2 networks of a company: DOIT Inc and IDIDT Inc. The RC-ISP, besides providing Internet connectivity to the companies, it also hosts services like DNS and HTTP on its Data Center. RC-ISP is responsible for the management of IPv4 and IPv6, providing addresses to its clients according to their needs.

DOIT, IDIDIT and RC-ISP have static and/or default routes to the other networks and the Internet, and well-configured NAT/PAT.

RC-ISP manages and allocates addresses from the following networks:

IPv4:   200.105.77.0/24
IPv6:   2002:ABCD:EF01::/48

RC-ISP has the following requirements of addresses for its networks:
- 112 servers with IPv4 public addresses, 60 for the Datacenter and 52 for the ITDep;
- Two networks /64 IPv6 for all its servers in its 2 networks.

RC-ISP delegates a /52 network prefix to distribute by both DOIT and IDIDIT.

DOIT Inc has the network divided in 3 parts:
- The *Offices* network for PCs, laptops, printers and other servers connected through Ethernet cables. This network uses 25 public IPv4 addresses for the servers/PCs, and uses IPv4 private addresses for the remaining terminals. All terminals have global IPv6 addresses.
- The WiFi network uses only private IPv4 and global IPv6 addresses (it has no public IPv4 addresses).
- The *Factory* network uses only IPv4 private addresses (has no public IPv4 nor global IPv6 addresses).

Additionally, DOIT Inc uses 16 IPv4 public addresses for NAT/PAT, so that terminals with private IPv4 addresses of *Offices* and Wireless networks can access the Internet.

DOIT Inc uses 192.168.4.0/22 for IPv4 private addressing. *Factory* needs 400 IPv4 private addresses, WIFI needs 200 IPv4 private addresses, and *Offices* needs 100 IPv4 private addresses.

1.   Considering the previous addresses:
a.   Define sub-networks IPv4 private (identifier and mask) for the network DOIT Inc. Justify. (1.5 points)
Hint: 192.168.4.0/23, 192.168.6.0/24, 192.168.7.0/25.
b.   Define sub-networks IPv4 public (identifier and mask) for the networks RC-ISP and DOIT Inc, including the NAT/PAT addresses. Justify. (1 point)
Hint: 200.105.77.0/26, 200.105.77.64/26, 200.105.77.128/27, 200.105.77.160/27 or /28.
c.   Define sub-networks IPv6 for RC-ISP and DOIT Inc networks (identifier and mask). Justify. (1 point)
Hint: RC-ISP: 2002:ABCD:EF01::/48 (2002:ABCD:EF01:1::/64 and 2002:ABCD:EF01:2::/64);
DOIt: 2002:ABCD:EF01:1000::/52   (2002:ABCD:EF01:1000::/64   and
2002:ABCD:EF01:1001:::/64);
IDItIt: 2002:ABCD:EF01:2000::/52.

2. Consider that a terminal just arrives at the DOIT WiFi network, which are the nodes that will need to update their tables (and which tables) when the terminal communicates with the Internet? Justify. (1.5 points)

Hint: Switching tables: WiFi, VLAN-Sw1/2, ESW1/2 switches; ARP tables: ESW1/2 switch; DHCP table: ESW1/2 or DoIt (depending where DHCP server is); NAT/PAT table: DoIt. Routing is already working and the terminal will not add any network in the routing table.

3. In the DOIT offices network, which node routes the packets between a private and a public terminal communication from the same Offices network? To justify, you can include the path of each packet in this communication (you can consider a simple ping communication). (1.5 points)

Hint: ESW1 or ESW2, since it is the gateway, it contains both network addresses and it is a router in the lower part (see VLAN guide exercise 4).

4. Do you need NAT/PAT to communicate between a private terminal in the DOIT offices network and the public DC-Server in RC-ISP? If yes, justify and include a translation table. (1.5 points)

Hint: Yes, since the private address is not known from the outside. The requirement is not because routing between private and public is not possible without NAT. NAT table: 192.168.7.1 (Inside local), 200.105.77.161 (Inside global), 200.105.77.1 (Outside global and Outside local).

5. Without DHCPv6 or manual configuration, is it possible for a terminal to acquire all information to communicate in IPv6? Justify. (1 point)

Hint: Yes. Network prefix through Router Advertisement from the router, and the terminal address through MAC or pseudo-random value.

6. Consider that the Wifi DOIT network is becoming very congested and that the retransmitted packets are being lost too. Is there a possibility to, according to the medium access mechanisms, still have slots for transmission? And does this recovery last forever? Justify. (1.5 points)

Hint: For each retransmission, the backoff interval is multiplied by 2, in a limit of 16 retries. RTS/CTS can also help to prevent this from happening.

7. Considering static and/or default routing, define the required routes in the DoIt router so that the DOIT network can communicate with the other networks and the Internet. Justify (1.5 points)

8. A terminal application in the *Offices* DOIT network opens a TCP Reno session with a terminal in the RC-ISP network with an initial sequence number of 234. The initial sequence number of the terminal in the RC-ISP network in this connection is 456. The size of the packets is 1000 bytes.

a) In the middle of the communication, with a congestion window of 55 packets and a very high reception window, a timeout occurs. How does the sender of that packet change its transmission rate? Justify. (1 point)

Hint: Congestion window goes to 1, therefore, the transmission rate is 1 packet with maximum size per round trip time.

b) Considering that 7 packets were sent by the Offices DOIT network and 11 packets were sent by the terminal in the RC-ISP network, all with full size, what is the sequence number in both directions in the last packet of the connection? Justify. (1.5 points)

Hint: From the DOIt: 234+1(SYN)+7000(data)+1(FIN)=7236; From the RC-ISP: 456+1(SYN)+11000 (data)+1(FIN)=11458.

c) While that session was active, UDP services have also started. Will UDP services have problems in their transmission due to this TCP session? Justify. (1.5 points)

Hint: UDP will send packets irrespective of losses; TCP will adapt the rate while losses happen; UDP will have some losses but will not be much affected due to the TCP adaptation.

9. Is there any possibility of having better performance in the DNS query with an iterative approach? Justify. (1 point)

Hint: It is difficult, but it may be better if the several levels of DNS servers are near the local server, and if they are apart from each other (long time with pending requests in the DNS servers in the recursive approach).

10. Why does FTP need 2 types of connections for file transfer? Justify. (1.5 points)

Hint: Control connection to handle the several functionalities (port 21) and Data connection to handle data transfer (port 20).

11. If you have a service that needs low delays between its packets, but no or very low losses, is there a possibility to transport these packets with those requirements? Propose an approach according to what you have learned in our classes. (1.5 points)

Hint: Use UDP-based to not adapt the rate and have low delays, but with a retransmission approach for the lost packets with some buffering to wait for the retransmissions if they are fast.