Aplicacions Web d'Última Generacío 2	Q1: 30-10-2017
Nombre:	Apellidos:

Test. 3 points.
Estimated time to complete: **2.5 minutes** each question (**25 minutes**).
Questions can have one single correct answer (RU) or multiple answers (MR) can be correct.

- A correct RU counts 0.2 points, 0 if there is at least a mistake.
- A correct MR counts 0.4 points, a partial correct (i.e., one single mistake) answer counts 0.2 points, 0 if there are more than 2 mistakes. There is always at least one correct answer in MR.

1. **MR.** Indicate which are the main characteristics of the peer-to-peer architecture

- ☐ A server is always active and connected to Internet, waiting requests from other nodes
- ☒ A server does not need to be connected all the time
- ☐ The communication between a client and a server is always established using TCP
- ☒ If a server of an application is not active, the client can still receive the service from other clients

2. **MR**. Indicate the correct statement/s

- ☒ The SLA is a contract between a customer and a provider establishing the QoS requirements
- ☐ The QoS is a contract between a customer and a provider establishing the application-layer protocol requirements
- ☒ The QoE is the user perception about the quality of the service received
- ☐ The network is directly in charge of providing specific QoE levels to the users

3. **RU**. The HTTP protocol defines different methods. Identify the methods used for sending data to a web site

- ☐ GET
- ☒ POST
- ☐ HEAD
- ☐ PUT
- ☐ DELETE

4. **RU**. Identify which of the following modules is in charge of ensuring the contractual traffic peak rate, average rate and burst size

- ☐ The token bucket traffic policer
- ☐ The leaky bucket traffic policer
- ☒ The token and the leaky bucket traffic policer in tandem
- ☐ The traffic shaper
- ☐ The admission controller

5. **RU**. Indicate the correct statement

- ☐ The integrated service is an IETF model that does not guarantee QoS services
- ☐ The differentiated service uses per-flow states reserving the required resources in the network to provide the required QoS
- ☐ The integrated service uses the Weighted Fair Queueing scheduling policy to provide per-flow QoS guarantees
- ☒ The differentiated service can use QoS scheduling policy in the core of the network to prioritize specific traffic

6. **MR**. Indicate the correct statement/s

- ☐ The difference between the non-persistent and persistent HTTP connections only affects the behaviour of downloading a web site
- ☒ In the case of persistent HTTP connection with pipelining, several objects of a same web site can be downloaded at the same time
- ☐ HTTP caching allows to maintain states in a web server in such a way that a user can be recognised
- ☒ An HTTP proxy can be used to avoid direct communication between a client and the web server

7. **MR**. Indicate which of the following commands belong to SMTP

- ☒ EHLO
- ☐ BCC
- ☒ RCPT TO
- ☐ EXIT
- ☒ DATA

8. **MR**. Regarding the email retrieval protocol

- ☒ In the case of POP, the client can store the email in the server and access them from any device
- ☒ POP uses authentication
- ☐ In the case of POP, a user can organise the email in different folders directly in the server
- ☒ In the case of IMAP, a user cannot download the emails locally in his mail application client

9. **MR**. Regarding the streaming protocols

- ☒ The buffer at the receiver is used to compensate the jitter
- ☒ The RTCP protocol can be used to send reports between client and servers to notify the quality of the reception
- ☐ The RTCP protocol sends reliable information, therefore the TCP transport layer protocol is used
- ☒ If a client receives a video content from 3 different servers, 3 different RTSP sessions are required between the client and the servers

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Short questions. 2.5 points.
Estimated time to complete: **25 minutes**.

1. Rewrite the following statement correcting the wrong parts:

The RTSP streaming protocol provides a service that is connection oriented, is in charge of transmitting packets containing audio/video data between two applications as well as configuring the buffer at the receiver.

The RTSP streaming protocol provides a service that is connection oriented, is in charge of transmitting packets containing COMMANDS between two applications WHILE IS NOT IN CHARGE OF configuring the buffer at the receiver.

2. Explain two (clearly and shortly, 3 lines maximum each) of the main differences between the HTTP-based and the RTP based streaming transmissions

HTTP uses TCP, so then the data is reliable and the retransmission may affect the view of the multimedia content.

RTP family allows a set of specific commands between client and server to improve the streaming vision.

3. Explain two (clearly and shortly, 3 lines maximum each) of the main differences between the client-server and the peer-to-peer architecture.

For the client-server architecture, the servers need to be always on (i.e., connected to the Internet and listening clients' requests). For the peer-to-peer, this is not needed.

Servers need to be placed strategically in many places to provide services to the clients, nowadays there are placed in datacenter infrastructure to avoid scalability problems. For the peer-to-peer case, the system can grow arbitrarily as any host can be both a client and a server and can be accessible from any place.

4. Complete the following table indicating Yes or Not

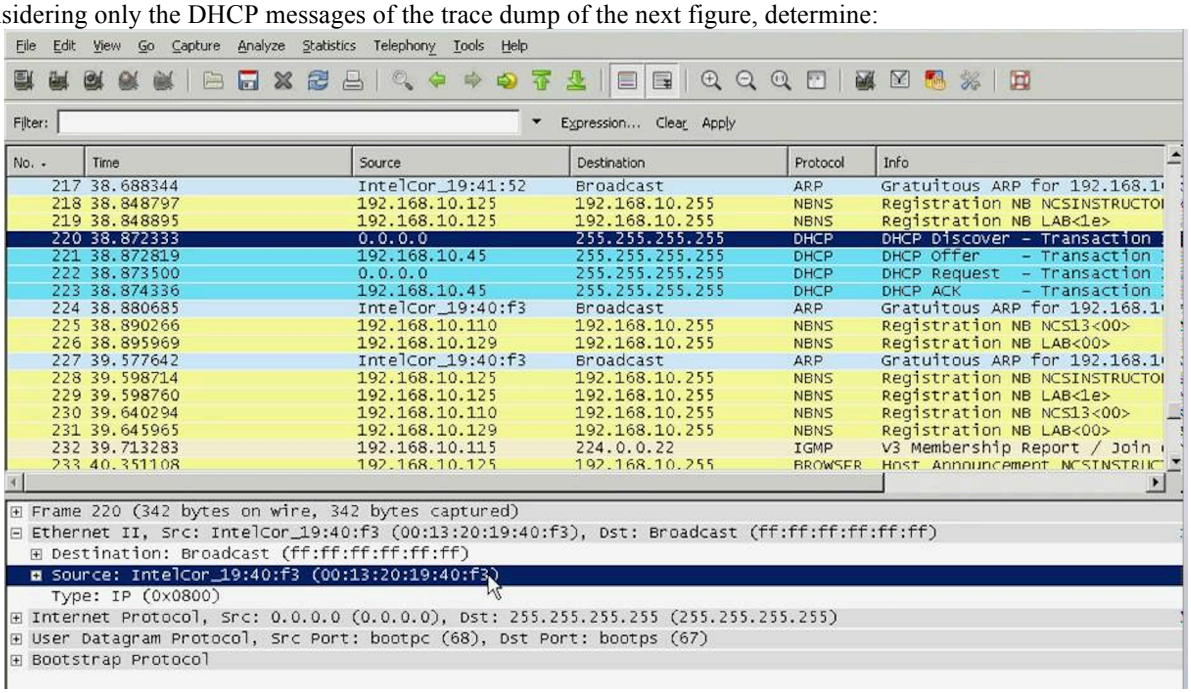
Application	Tolerant to moderate data lost	Very sensible to the end-to-end delay	Lightly sensible to the end-to-end delay	Sensible to the jitter	Minimum bounded throughput
RPG videogames	Yes/No*	Yes	No	Yes	Yes
Drive (google)	No	No	No	No	No
TV over Internet	Yes	Yes	No	Yes	Yes
DNS	Yes	No	No	No	No
Youtube	No**	No	Yes	Yes	Yes
Spotify	No***	No	Yes	Yes	Yes

* The a/v content of a videogame can be tolerant to moderate data lost but NOT the commands/actions performed by the player
** Youtube uses HTTP-based application protocol, so it is based on TCP and cannot tolerate data losses. Usually, the content in Youtube is stored so it is only lightly sensible to the delay.
*** Spotify does not use a web-based protocol, it is based on a peer-to-peer architecture with reliable (TCP) transmission.

5. Indicate which of the previous type of applications prefers the use of TCP instead of UDP. Justify the answer (clearly and shortly, 2 lines maximum).

TCP: videogames (actions), Drive, Youtube and Spotify
UDP: videogames (a/v content), TV over Internet, DNS

6. Considering only the DHCP messages of the trace dump of the next figure, determine:



a) The @IP of the client and of the server

Client: 0.0.0.0 Server: 192.168.10.45

b) If UDP or TCP is used

UDP

c) The ports of the two applications involved in this message interchange

Client port: 68
Server port: 67

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Problems. 4.5 points.
Estimated time to complete: **40 minutes**.

Problem 1.

A client wants to download the website www.examen.com using HTTP. The page contains an HTML document with 5 objects:

- 1 picture and 1 audio hosted in the same server,
- 2 pictures and 1 video hosted in the server cdn.akamai.com

Consider that:

- the RTT between the client and the server www.examen.com is 50 ms
- the RTT between the client and the server cdn.akamai.com is 25 ms
- the time to establish the TCP connection is 1.5 RTT
- the time to close the TCP connection is 2 RTT
- the time to download the HTML is 2 RTT
- the time to download each picture is 10 RTT, the video is 100 RTT and the audio is 20 RTT

Determine:

a) Number of RTT needed to download the web site using HTTP/1.0 non-persistent.
b) Number of TCP connections required in total in this case
c) Number of RTT needed to download the web site using HTTP/1.1 persistent.
d) Number of TCP connections required in total in this case
e) If the objective is to reduce the total downloading time to 2 seconds, determine the maximum value should have the RTT between the client and the server cdn.akamai.com

a) The client is connected with the server www.examen.com → 1,5 RTT (1,5 x 50 ms = 75 ms)
The client sends the GET of the HTML and download it → 2 RTT (2x50 ms = 100 ms)

The client finds 5 references to 5 objects in the HTML stored in two different servers. It needs to communicate to each server to download them in parallel.

This initial phase is common for both servers and requires 75 + 100 = 175 ms

1) The server www.examen.com closes the connection → 2 RTT (2 x 50 = 100 ms)
The client reopens the connection → 1,5 RTT (1,5 x 50 = 75 ms)
The client sends the GET of the picture and get it → 10 RTT (10 x 50 = 500 ms)
The server www.examen.com closes the connection → 2 RTT (2 x 50 = 100 ms)
The client reopens the connection → 1,5 RTT (1,5 x 50 = 75 ms)
The client sends the GET of the audio and get it → 20 RTT (20 x 50 = 1000 ms)
The server www.examen.com closes the connection → 2 RTT (2 x 50 = 100 ms)

The objects from this server have been downloaded in
175 (initial) + 100 (close) + 75 (open) + 500 (picture) + 100 (close) + 75 (open) + 1000 (audio) = 2025 ms

2) The client opens the connection with cdn.akamai.com → 1,5 RTT (1,5 x 25 = 37,5 ms)
The client sends the GET of the first picture and get it → 10 RTT (10 x 25 = 250 ms)
The server closes the connection → 2 RTT (2 x 25 = 50 ms)
The client reopens the connection → 1,5 RTT (1,5 x 25 = 37,5 ms)
The client sends the GET of the second picture and get it → 10 RTT (10 x 25 = 250 ms)
The server closes the connection → 2 RTT (2 x 25 = 50 ms)
The client reopens the connection → 1,5 RTT (1,5 x 25 = 37,5 ms)
The client sends the GET of the video and get it → 100 RTT (100 x 25 = 2500 ms)
The server closes the connection → 2 RTT (2 x 25 = 50 ms)

The objects from this server have been downloaded in
175 (initial) + 37,5 (open) + 250 (1st picture) + 50 (close) + 37,5 (open) + 250 (2nd picture) +
+ 50 (close) + 37,5 (open) + 2500 (video) = 3387,5 ms

This second one is larger, so the downloading time is 3387,5 ms.

b) There are 5 objetos and the HTML document to download, therefore 6 TCP connections are required.

c) The client is connected with the server www.examen.com → 1,5 RTT (1,5 x 50 ms = 75 ms)
The client sends the GET of the HTML and download it → 2 RTT (2x50 ms = 100 ms)

The client finds 5 references to 5 objects in the HTML stored in two different servers. It needs to communicate to each server to download them in parallel.

This initial phase is common for both servers and requires 75 + 100 = 175 ms

1) The client sends the GET of the picture and get it → 10 RTT (10 x 50 = 500 ms)
   The client sends the GET of the audio and get it → 20 RTT (20 x 50 = 1000 ms)
   The server www.examen.com closes the connection → 2 RTT (2 x 50 = 100 ms)

   The objects from this server have been downloaded in
   175 (initial) + 500 (picture) + 1000 (audio) = 1675 ms

2) The client opens the connection with cdn.akamai.com → 1,5 RTT (1,5 x 25 = 37,5 ms)
   The client sends the GET of the first picture and get it → 10 RTT (10 x 25 = 250 ms)
   The client sends the GET of the second picture and get it → 10 RTT (10 x 25 = 250 ms)
   The client sends the GET of the video and get it → 100 RTT (100 x 25 = 2500 ms)
   The server closes the connection → 2 RTT (2 x 25 = 50 ms)

   The objects from this server have been downloaded in
   175 (initial) + 37,5 (open) + 250 (1st picture) + 250 (2nd picture) + 2500 (video) = 3212,5 ms

   This second one is larger, so the downloading time is 3212,5 ms.

d) There are 5 objetos and the HTML document to download from 2 different servers, therefore 2 TCP connections are required.

e) 2000 – 175 = 1825 ms
   there are 1,5+10+10+100 RTT = 121,5 RTT in total

   1825 ms / 121,5 RTT = 15,02 ms/RTT

   The RTT has to be lower than 15 ms to have a total downloading time less than 2 seconds.

Problem 2.

Consider that a user with email mark@facebook.com wants to send an e-mail to bill@microsoft.com, a copy to dustin@facebook.com and a blind copy to steve@apple.com. Determine:

a) Which messages (number, type and content) have to be sent between the host of the user and his mail server.
b) Which messages (number, type and content) have to be sent between the host mail server and the destination mail servers.

a) After the TCP connection establishment, the interchange of SMTP messages starts between the client and the server:

- Client -> Server: HELO
- Server -> Client: OK
- Client -> Server: MAIL FROM: mark@facebook.com
- Server -> Client: OK
- Client -> Server: RCPT TO: bill@microsoft.com
- Server -> Client: OK
- Client -> Server: RCPT TO: dustin@facebook.com
- Server -> Client: OK
- Client -> Server: RCPT TO: steve@apple.com
- Server -> Client: OK
- Client -> Server: DATA
- Server -> Client: start mail
- Client -> Server: SEND THE HEADER
  From: Mark
  To: Bill
  CC: Dustin
  Subject: Test
  Date: 10/11/2017
- Client -> Server: SEND THE BODY
  .
- Server -> Client: OK
- Client -> Server: QUIT
- Server -> Client: close

b) The local mail server of the domain facebook.com has now to retransmit the email to the mail server of the destinations. The domain of dustin@facebook.com is facebook.com, i.e., it is the same of the source. Therefore, Dustin is a user of the same mail server and a copy of the email sent by Mark will be stored in the Dustin's mailbox. No further action requires the use of SMTP. The user Dustin can now download his emails from the mail server using POP, IMAP or HTTP.

On the other side, Bill's domain is microsoft.com and Steve's domain is apple.com which are different than the source one. Therefore, the mail server of the domain twitter.com sends a copy of the email to the mail server of the microsoft.com domain and another copy to the mail server of the apple.com domain. The different with respect to a) is that now only one RCPT TO command is used to each mail server destination: Bill user is registered in the microsoft.com mail server and Steve in the apple.com one.

To microsoft.com mail server	To apple.com mail server
• Client -> Server: HELO • Server -> Client: OK • Client -> Server: MAIL FROM: mark@facebook.com • Server -> Client: OK • Client -> Server: RCPT TO: bill@microsoft.com • Server -> Client: OK • Client -> Server: DATA • Server -> Client: start mail • Client -> Server: SEND THE HEADER From: Mark To: Bill CC: Dustin Subject: Test Date: 10/11/2017 • Client -> Server: SEND THE BODY . • Server -> Client: OK • Client -> Server: QUIT • Server -> Client: close	• Client -> Server: HELO • Server -> Client: OK • Client -> Server: MAIL FROM: mark@facebook.com • Server -> Client: OK • Client -> Server: RCPT TO: steve@apple.com • Server -> Client: OK • Client -> Server: DATA • Server -> Client: start mail • Client -> Server: SEND THE HEADER From: Mark To: Bill CC: Dustin Subject: Test Date: 10/11/2017 • Client -> Server: SEND THE BODY . • Server -> Client: OK • Client -> Server: QUIT • Server -> Client: close