Université Nice Sophia Antipolis
International Master in Computer Science

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Duration : 2h

Networking 1
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- *The utilization of any document or electronic device is forbidden. Your arguments must be clear, well written and must not be longer than 5 lines (There is no penalty for exceeding the lines count, but we will stop reading once the line limit has been reached).*
- Each question corresponds to one point, except the ones with a star that correspond to two points.

Exercice 1: Basic knowledge

1. Sort the TCP/IP layers from bottom to top : physical layer, application layer, data link layer, transport layer, network layer. Which layers are end-to-end layers and which are local layers ?
2. Give the definition of a protocol.
3. What are the two transport layer services that Internet offers to applications ?
4. Give two examples of application layer protocols. Same question for the transport layer and the data link layer (2 examples each time).
5. Which layers of the TCP/IP model are implemented in a router in the core of the Internet ?

Exercice 2: Adressing

Let us consider Figure 1 that depicts a set of commands executed on a laptop connected to a residential ADSL connection.

```
~  $ ifconfig en1
en1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        ether f0:b4:79:16:ab:e5
        inet 192.168.0.100 netmask 0xffffff00 broadcast 192.168.0.255
        media: autoselect
        status: active
~  $ arp -a
? (192.168.0.1) at 0:1e:58:b5:65:9d on en1 ifscope [ethernet]
? (192.168.0.255) at (incomplete) on en1 ifscope [ethernet]
~  $ nslookup www.yahoo.fr
Server:         192.168.0.1
Address:        192.168.0.1#53

Non-authoritative answer:
www.yahoo.fr    canonical name = rc.yahoo.com.
rc.yahoo.com    canonical name = rc.g01.yahoodns.net.
rc.g01.yahoodns.net     canonical name = any-rc.a01.yahoodns.net.
Name:   any-rc.a01.yahoodns.net
Address: 77.238.178.122
Name:   any-rc.a01.yahoodns.net
Address: 87.248.120.148
```

FIGURE 1 – Listing of commands

1. What is the IP address of the resolver of the machine ?
2. Why is the answer to nslookup tagged ”Non-authoritative Answer” ?
3. What is a ”canonical name” ?
4. What is the IP address of the gateway and its MAC address ?

5. (*) Let us consider a frame sent by the local laptop to the Web server www.yahoo.fr. This frame is captured using wireshark when it leaves the local host. Do a simple drawing with the data link/network/transport layers with the addresses at each level.

Exercice 3: HTTP

```
~  $ telnet lprt.unice.fr 80
Trying 134.59.29.60...
Connected to geii-haproxy.unice.fr.
Escape character is '^]'.
GET /images/stories/p5_smq/manuel_qualite/unice.jpg HTTP/1.1
Host: lprt.unice.fr

HTTP/1.1 200 OK
Date: Mon, 17 Dec 2012 20:06:53 GMT
Server: Apache/2.2.22 (Ubuntu)
Last-Modified: Wed, 14 Mar 2012 10:52:39 GMT
ETag: "11fdf4-832-4bb31c625cbc0"
Accept-Ranges: bytes
Content-Length: 2098
Connection: close
Content-Type: image/jpeg
X-Pad: avoid browser bug
Set-Cookie: webpool=gpu1; path=/

JFIF``C




 $.' ",#(7),01444'9=82<.342C


2!!22222222222222222222222222222222222222222222222223?"

?}!1AQa"q2??#B??R??$3br?
```

FIGURE 2 – Telnet connection to a Web server

Let us consider the HTTP conversation of Figure 2.

1. Which transport layer does telnet use and why ?
2. What is the complete requested URL ?
3. Is the requested object available ? Justify.
4. What do the lines starting from "JFIF..." to the end of the figure ? Why are we sure that the figure does not depict the complete requested object ?
5. Is the connection persistent or not ? Does the server close the connection after sending the object ?

Exercice 4: Bufferisation with YouTube

Video and audio streaming heavily relies on buffering at the client side. Let us a consider a toy example to illustrate the complexity of picking the right value for the buffering delay (time before playing the video to the user). Assume that :

– YouTube transfers a video that must be read at R=300 kps
– The access capacity of the client is R0=200 kbps
– The duration of the video is T=10 minutes

Let us call :

– $t = 0$ the time instant when the YouTube server starts streaming the content.

– $t = t_0$ the time at which the video is being played to the user.

Questions :

1. Which quantity of data is buffered during the buffering period $[0, t_0]$.
2. (*) To have no image freeze, it is sufficient that the quantity of information received during the buffering period + the playout duration be smaller than the quantity of information consumed by the player during time T . Write the corresponding equation.
3. What is the minimum buffering time ?
4. Why is it more complex in practice for YouTube in practice ?

Exercice 5: DHCP

Questions :

1. What is the expected behavior of a DHCP client if the DHCP renew packet is lost ?
2. (*) You have created a new DHCP option, with Id number 214, that will indicate the desired lease time. The desired lease time will be indicated in number of hours and coded in only one byte. Write what should be added to a DHCP request packet (in hexadecimal format, exactly like it should be displayed by wireshark) if you want to indicate a lease time of 5 hours.

Exercice 6: BSD Sockets

Questions :

1. You are writing an application that periodically indicate to the users of a freeway the congestion level of the route. Write the call to the `socket` primitive exactly like you should write it in your program, assuming that the service will run over an IP network infrastructure. If a variable is needed (to pass arguments or catch a result), you must declare it and initialize it first.
2. Explain the differences between the `send` and `sendto` primitives.
3. Explain the expected behavior of an UDP server and client if the client send an infinity number of messages to the server, with zero delay between two successive transmissions, but the server is able to read only one message per second.
4. (*) Explain the expected behavior of a TCP server and client if the client send an infinity number of messages to the server, with zero delay between two successive transmissions, but the server is able to read only one message per second.

Exercice 7: Congestion Control

A TCP client with a send buffer of 6000 bytes will send 10000 bytes, generated by the application, to a server with a receive window size of 2000 bytes. The sequence numbers, randomly generated, by the sender and the receiver are 1000 and 2000 respectively. Suppose that (i) the MSS is 1020 bytes (header + payload) ; (ii) the length of the ACKs and FINs packets, and the TCP header is equal to 20 bytes ; (iii) the length of the SYN and SYNACK packets is equal to 40 bytes ; (iv) the receiver consumes only 1000 bytes/RTT, but any other TCP packet is instantaneously consumed by both, the sender and the receiver.

Questions :

1. (*) Show graphically the progress of the connection, by adding each event to the sequence diagram in the Figure 3, from the connection establishment to the connection closure sequence.
2. (*) Show graphically the progress of the congestion window in Figure 4. Plot the congestion window size as a function of time (units of RTT).

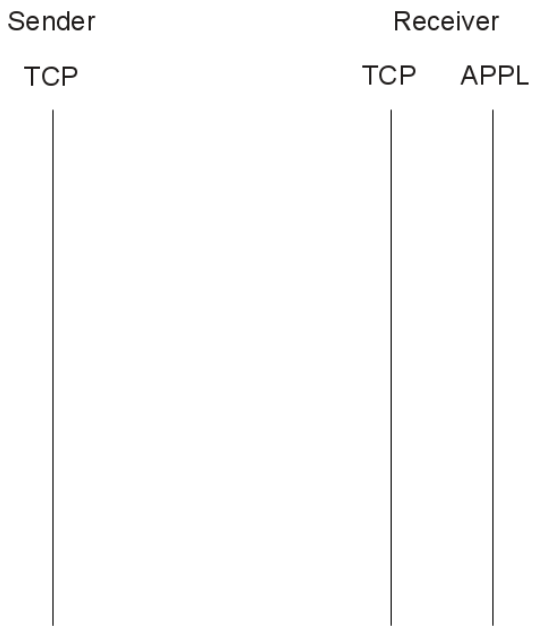

FIGURE 3 – Sequence Diagram

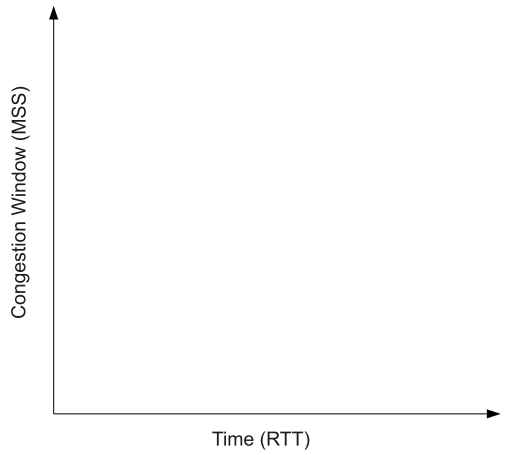

FIGURE 4 – Congestion Window Evolution