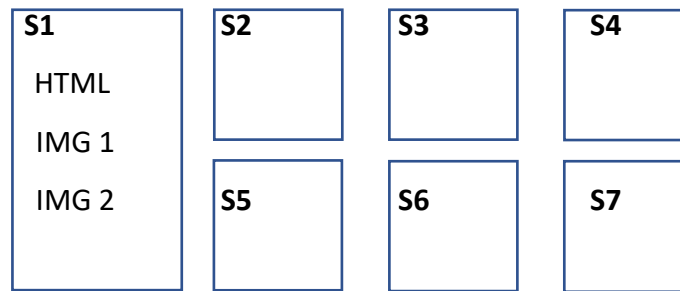


Problem 1

1.



RTT 1: TCP with **S1**

RTT 2: HTML doc

RTT 3: IMG 1

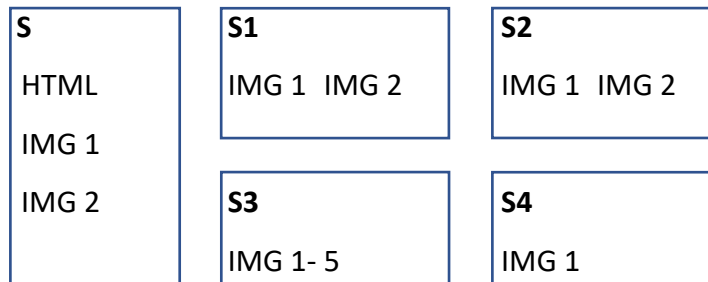
RTT 4: IMG 2

6 RTTs: Establish TCP connection with servers **S2 – S7**

10 RTTs: Request and receive 10 images

Total: 20 RTTs

2.



RTT 1: TCP with **S**

RTT 2: HTML

RTT 3: IMG 1

RTT 4: IMG 2

RTT 5: TCP with **S1**

RTT 6: IMG 1 (**S1**)

RTT 7: IMG 2 (**S1**)

RTT 8: TCP with **S2**

RTT 9: IMG 1 (**S2**)

RTT 10: IMG 2 (**S2**)

TCP with **S3**

IMG 1 (**S3**)

IMG 2 (**S3**)

IMG 3 (**S3**)

IMG 4 (**S3**)

IMG 5 (**S3**)

TCP with **S4**

IMG 1 (**S4**)

Total: 10 RTTs

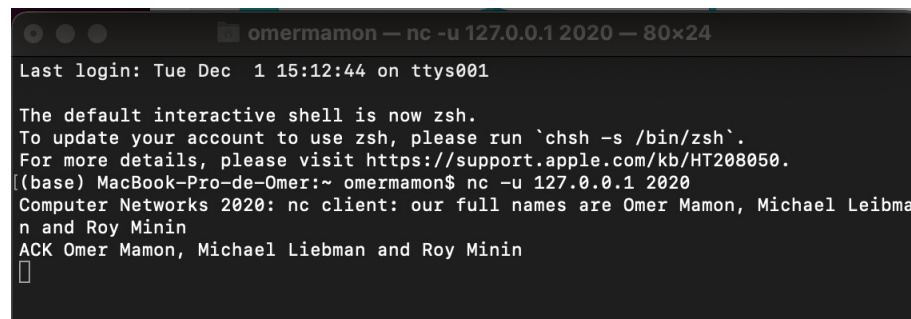
Problem 2

- a. The RFC specifies HTTP. Upgrade is defined in section 6.7, it is used by both client-side and server-side.
- b. Domain System and Protocol; CNAME is discussed in section 3.3.1
- c. DNS Extensions to Support IP v6; AAAA is defined in section 2.1
- d. Simple Mail Transfer Protocol (SMTP), Section 2; SMTP encourages the transmission of only one copy of the data for all recipients at the same destination host.
- e. DNS query over HTTP (DoH); HTTP/2 is the minimum recommended version as discussed in section 5.2
- f. DNS over TLS, DNS over DTLS; the first mention of port 853 occurs in section 8.2 DANE. It is a disadvantage as a dedicated port for DoT means anyone can see traffic coming and going.
- g. HTTP, section 6
- h. HTTP Strict Transport Security, section 5 discusses the HSTS mechanism.

Problem 3

- a. UDP:

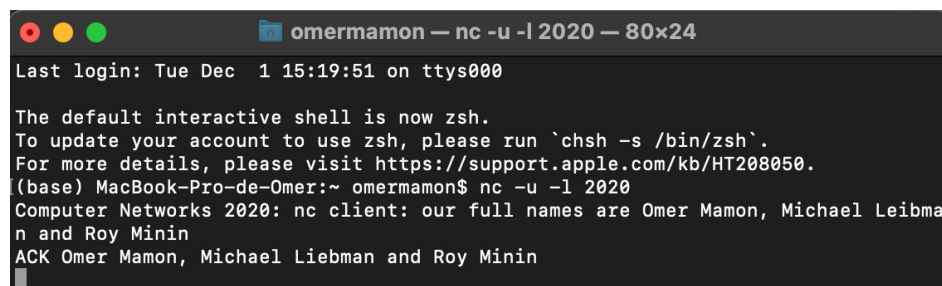
Client:



```
omermamon — nc -u 127.0.0.1 2020 — 80x24
Last login: Tue Dec 1 15:12:44 on ttys001

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
(base) MacBook-Pro-de-Omer:~ omermamon$ nc -u 127.0.0.1 2020
Computer Networks 2020: nc client: our full names are Omer Mamon, Michael Leibman and Roy Minin
ACK Omer Mamon, Michael Liebman and Roy Minin
```

Server:



```
omermamon — nc -u -l 2020 — 80x24
Last login: Tue Dec 1 15:19:51 on ttys000

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
(base) MacBook-Pro-de-Omer:~ omermamon$ nc -u -l 2020
Computer Networks 2020: nc client: our full names are Omer Mamon, Michael Leibman and Roy Minin
ACK Omer Mamon, Michael Liebman and Roy Minin
```

TCP:

Client:

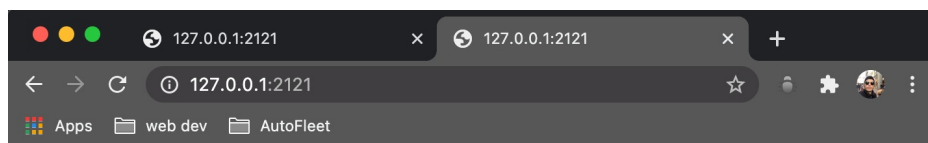
```
omermamon — nc 127.0.0.1 2020 — 80x24
Last login: Tue Dec 1 15:12:39 on ttys000
The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
(base) MacBook-Pro-de-Omer:~ omermamon$ nc 127.0.0.1 2020
Computer Networks 2020: nc client: our full names are Omer Mamon, Michael L Leibman and Roy Minin
ACK Omer Mamon, Michael Leibman and Roy Minin
```

Server:

```
omermamon — nc -l 2020 — 80x24
Last login: Tue Dec 1 15:12:32 on ttys001
The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
(base) MacBook-Pro-de-Omer:~ omermamon$ nc -l 2020
Computer Networks 2020: nc client: our full names are Omer Mamon, Michael Leibman and Roy Minin
ACK Omer Mamon, Michael Leibman and Roy Minin
```

b. It is not possible: as we open the second server it will take the old server and only the last one will work for the specific port.

c.



Class 2020/21

```
omermamon — ncat -v -k -l 2121 — 156x55
Last login: Tue Dec 1 16:12:37 on ttys000
The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
(base) MacBook-Pro-de-Omer:~ omermamon$ ncat -v -k -l 2121
Ncat: Version 7.91 ( https://nmap.org/ncat )
Ncat: Listening on :::2121
Ncat: Listening on 0.0.0.0:2121
Ncat: Connection from 127.0.0.1.
Ncat: Connection from 127.0.0.1:58863.
Ncat: Connection from 127.0.0.1.
Ncat: Connection from 127.0.0.1:58864.
GET / HTTP/1.1
Host: 127.0.0.1:2121
Connection: keep-alive
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 11_0_1) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/87.0.4280.66 Safari/537.36
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9
Sec-Fetch-Site: none
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9,he;q=0.8
GET / HTTP/1.1
Host: 127.0.0.1:2121
Connection: keep-alive
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 11_0_1) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/87.0.4280.66 Safari/537.36
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9
Sec-Fetch-Site: none
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9,he;q=0.8
HTTP/1.1 200 OK
Content-Length: 13
```

No, as we can see, one is from 58863, the other is from 58864. Both tabs get the same response.

Problem 4

See attached folder for high resolution screen captures and Java code

Problem 5

1. The maximum required rounds is 2. The algorithm for process p_i with input in_i :

Initialize: $v \leftarrow in_i$, $flag \leftarrow true$, $round \leftarrow 0$, $temp$

While ($round < 2$)

$round \leftarrow round + 1$

 if $flag = true$: send v to all processes

 wait to receive all messages for this round

$temp \leftarrow v$

$v \leftarrow \min\{\text{all received values at this round and current value of } v\}$

 if $v < temp$: $flag \leftarrow true$

 else: $flag \leftarrow false$

decide on v

- 2.