



Computer Engineering II

Solution to Exercise Sheet Chapter 4

1 Quiz Questions

- a) A user provides his login credentials. The server then returns a cookie with a session ID associated with the server side information about the user, the session data. Including the username and password in the URL, called *Basic Authentication*, is not commonly used:
- It shows a popup that integrates poorly with the look and feel of most webpages.
 - Copy-pasting a URL may result in the credentials being leaked.
- b) It may be ambiguous whether the client is using encrypted or unencrypted requests. For encrypted transmissions also the header is encrypted. In rare cases, the encryption might result in a valid header for the unencrypted protocol. If the protocol version is known, acting according to the specification is straightforward. A protocol can usually be extended with an upgrade command which bootstraps the encrypted communication. With SMTP for instance, **STARTTLS** upgrades a plaintext connection after the initial handshake to use Transport Layer Security (TLS).
- c) No. Nowadays most users deliver outgoing mails to their provider's outgoing mailserver which then takes care of forwarding the mail to the destination. This adds authentication since the outgoing mailserver can now certify that the mail was sent by a legitimate user and it may attempt delivery multiple times should the destination mailserver not be reachable.
- d) Yes, the server may have a cached response to the resolution request and respond directly without having to perform the entire resolution. Should the server not have a cached response the overhead of using an intermediate server is minimal since the ISP is on the communication path to the authoritative nameserver anyway.
- e) There are at least 3 connections being opened:
- The first connection is opened to retrieve `http://google.ch/`. This page redirects (status code 301) to the domain `http://www.google.ch/` which may not be served by the same server.
 - The second connection is opened to retrieve `http://www.google.ch/` (port 80) redirects to `https://www.google.ch/` (port 443) which is not on the same port.
 - The third connection actually retrieves the content of the webpage. Additional connections may then be opened to retrieve referenced resources in parallel.

2 Send me a comment

- a) Depending on the website you visited there will be an initial connection to retrieve the HTML page followed by a cascade of resources referenced in the HTML page. Since each of the resources may itself reference some other resources it is not uncommon to see multiple waves of parallel requests.

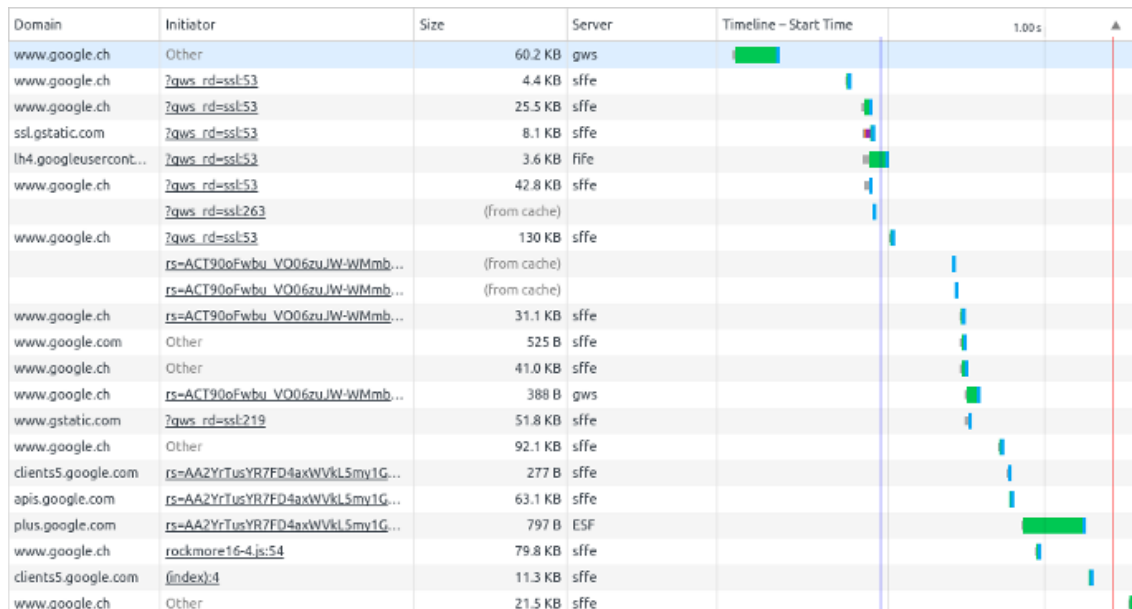


Figure 1: The waterfall of requests when opening a simple webpage.

- b) The following is an example HTTP request and response:

```
1 # telnet virt13.ethz.ch 80
2 Trying 82.130.102.226...
3 Connected to virt13.ethz.ch.
4 GET / HTTP/1.1
5 Host: virt13.ethz.ch
6
7 HTTP/1.1 200 OK
8 Transfer-Encoding: chunked
9 Date: Wed, 09 Mar 2016 15:15:54 GMT
10 Content-Type: text/html
11 Server: TwistedWeb/15.5.0
12
13 249
14
15 <html>
16   <head>
17     <title>Disco Comments</title>
18     <link href="http://getbootstrap.com/dist/css/bootstrap.min.css" rel
19         ="stylesheet" />
20   </head>
21   <body lang="en">
22     <header class="navbar navbar-static-top">
23       <div class=container>
```

```

23     <div class=navbar-header>
24         <div class=navbar-brand>Disco Comments</div>
25     </div>
26     <div>
27 </header>
28 <div class=container>
29     <div class="col-md-12">
30         <dl>
31             <dt id="mid-0">Disco</dt>
32             <dd>Welcome to the Disco Comment page</dd>
33         </dl>
34     </div>
35 </div>
36 </body>
37 </html>
38 0
39
40 Connection closed.

```

The request (lines 4-6) specifies that HTTP/1.1 is to be used, hence the connection will remain open for a few seconds before the server closes it due to a timeout. The `host` header field was introduced in HTTP/1.1 and allows one machine to serve multiple domains. The response header (lines 7-12) returns some information about the server and metadata about the response. Notice that the Transfer-Encoding is set to `chunked` which means that the server returns the response in multiple chunks, each prefixed with the number of bytes (as hexadecimal numbers) on a separate line. In this case we have two chunks, one of 249_{hex} bytes starting at line 13 and another chunk of 0_{hex} bytes, indicating the end of the response, starting at line 38.

- c) As mentioned we need to construct a POST request to resource `/`. The following sends the message `hello world` to the server.

```

1 # telnet virt13.ethz.ch 80
2 Trying 82.130.102.226...
3 Connected to virt13.ethz.ch.
4 POST / HTTP/1.1
5 Host: virt13.ethz.ch
6 Content-Length: 11
7
8 hello world
9 HTTP/1.1 201 Created
10 Transfer-Encoding: chunked
11 Date: Wed, 09 Mar 2016 15:30:37 GMT
12 Content-Type: text/html
13 Server: TwistedWeb/15.5.0
14
15 18
16 Comment added with ID 3
17
18 0

```

The request now includes a `Content-Length` option which tells the server how many bytes to read. The request spans lines 4-8, including the payload on line 8.

3 Send me a mail

- a) Sending a mail to `somebody@virt13.ethz.ch` will not work because when searching for the responsible mailserver for the domain `virt13.ethz.ch` using DNS, no MX record is returned, hence the sender is unable to find the responsible server.¹
- b) The following is a valid SMTP session:

```
1 telnet virt13.ethz.ch 25
2 Trying 82.130.102.226...
3 Connected to virt13.ethz.ch.
4 220 cd652f72069f NO UCE NO UBE NO RELAY PROBES ESMTP
5 EHLO mail.ethz.ch
6 250 cd652f72069f Hello 82.130.102.226, nice to meet you
7 MAIL FROM: someone@student.ethz.ch
8 250 Sender address accepted
9 RCPT TO: recipient@virt13.ethz.ch
10 250 Recipient address accepted
11 DATA
12 354 Continue
13 This is a test message
14 that spans multiple lines
15 .
16 250 Delivery in progress
17 QUIT
18 221 See you later
19 Connection closed by foreign host.
```

This is an interactive session with the SMTP server, lines starting with a number are sent by the server. The client needs to identify itself using the `EHLO` command on line 5. On lines 7 and 9 we specify sender and recipient, notice that the sender needs to be specified before the recipient. The `DATA` command is then used to start the content transfer, which is terminated on line 15 with a single dot on a line.

- c)

```
1 import java.io.*;
2 import java.net.*;
3
4 public class Send_Mail_Client
5 {
6     public static void main(String[] args) throws IOException
7     {
8         String host = "virt13.ethz.ch";
9         int port = 25;
10
11         String client_name = "mail.ethz.ch";
12         String sender_address = "someone@student.ethz.ch";
13         String recipient_address = "recipient@virt13.ethz.ch";
14         String message = "This is a test message\nthat spans multiple lines
15             ";
16         Socket sock = new Socket(host, port);
```

¹However, some mail servers apparently try to use the `A` or `AAAA` DNS entry if no `MX` entry can be found. Like this, mail may be correctly delivered if the mail server is running on the same machine as the web server.

```

17     PrintWriter out = new PrintWriter(sock.getOutputStream());
18     BufferedReader in = new BufferedReader(new InputStreamReader(sock.
        getInputStream()));
19
20     System.out.println(in.readLine());
21
22     out.print("EHLO " + client_name + "\r\n");
23     out.flush();
24
25     System.out.println(in.readLine());
26
27     out.print("MAIL FROM: " + sender_address + "\r\n");
28     out.flush();
29
30     System.out.println(in.readLine());
31
32     out.print("RCPT TO: " + recipient_address + "\r\n");
33     out.flush();
34
35     System.out.println(in.readLine());
36
37     out.print("DATA\r\n");
38     out.flush();
39
40     System.out.println(in.readLine());
41
42     out.print(message + "\r\n.\r\n");
43     out.flush();
44
45     System.out.println(in.readLine());
46
47     out.print("QUIT\r\n");
48     out.flush();
49
50     System.out.println(in.readLine());
51
52     System.out.println("Done");
53 }
54 }

```

To execute this code, put it into a file named `Send-Mail_Client.java`, then compile the code using the Java compiler, and run the the generated class file:

```

$ javac Send-Mail_Client.java
$ java Send-Mail_Client

```

4 HTML

The following HTML code will render the page that was specified in the question.

```
1 <!DOCTYPE html>
2 <html>
3   <head>
4     <style>
5       p.intro {
6         font-size:20px;
7         color:white;
8         background-color:green;
9         border: 1px solid black;
10      }
11     table {
12       border-collapse: collapse;
13       width: 50%;
14       table-layout: fixed;
15     }
16     td, th {
17       border: 1px solid black;
18       text-align: right;
19     }
20   </style>
21 </head>
22 <body>
23   <div><font color="blue">Blue text.</font></div>
24   <div><font face="courier">Courier font.</font></div>
25   <div><a href="https://www.google.com/">Link, which when clicked should
26     go to Google.com.</a></div>
27   <div>There should be something <strong>bolded</strong>.</div>
28   <div>There should also be something <mark>highlighted</mark>.</div>
29   <div>The molecular formula of water is H<sub>2</sub>O.</div>
30   <div>Is <del>strikethrough</del> a valid way to communicate?</div>
31   <div align="center">Can we center some text?</div>
32   <div align="center"><font color="blue" face="courier"><strong><del>Bold
33     courier strikethrough in blue.</del></strong></font></div>
34   <div>
35     <p class="intro">
36       This section's rendering is controlled by CSS. It has a font size of
37       20px, the text color is white, the background color is green,
38       and the border is 1px of solid black.
39     </p>
40     <table>
41       <caption>Favorite Movies of Random People (Table styling done in CSS)
42     </caption>
43     <thead>
44       <tr>
45         <th>Name</th>
46         <th>Favorite Movie</th>
47       </tr>
48     </thead>
49     <tbody>
50       <tr>
```

```

46         <td>Rafa</td>
47         <td>Eternal Sunshine of the Spotless Mind</td>
48     </tr>
49     <tr>
50         <td>Roger</td>
51         <td>Primer</td>
52     </tr>
53     <tr>
54         <td>Novak</td>
55         <td>Groundhog Day</td>
56     </tr>
57 </tbody>
58 </table>
59 </div>
60 <div>
61 <p>
62     Note that the table above takes 50% of the width of the browser.
63 </p>
64 </div>
65 </body>
66 </html>

```

5 DNS

5.1 Getting Started

- a)
 - If you are outside the ETH network: `dig disco.ethz.ch` or `dig +domain=ethz.ch disco`
 - If you are within the ETH network: `dig disco.ethz.ch`
- b) CNAME stands for Canonical Name. The entry `disco.ethz.ch. 101 IN CNAME www-disco.ethz.ch.` should be read as: `disco.ethz.ch` is an alias for the CNAME (true name) `www-disco.ethz.ch.` Using CNAMEs, we can point several aliases to the same CNAME, which in turn points to one IP address. Therefore, if an IP address changes, one only has to change one entry (namely the A or AAAA record).
- c) A stands for Address. An A record maps a DNS name to an IPv4 address. AAAA records are used for IPv6 addresses.
- d) There are four mail servers in the `ethz.ch` domain: `phil[1-4].ethz.ch`. You can use the command `dig -t mx ethz.ch` to get this result. The number in front of the DNS names indicates a preference for the mail servers. If there are several mail servers, the one with the lowest number should be tried first. In our case, all mail servers have the same preference number and will be treated equally, i.e., the mail server is chosen uniformly at random.
- e) `disco.` is a Fully-Qualified Domain Name (FQDN) and therefore not in the `ethz.ch` domain. `disco` on the other hand is a relative domain name, and can therefore be found under `disco.ethz.ch..`

5.2 DNS Queries

- a) Typing `dig` will return all root servers.
- b) `dig +norec @a.root-servers.net disco.ethz.ch`. The root servers do not know `disco.ethz.ch`. However, they know the name servers of the `ch.` top-level domain. So, the root servers cannot give us an answer directly, but they return a list of name servers that might know the answer.
- c) `dig +norec @a.nic.ch disco.ethz.ch` and `dig +norec @ns1.ethz.ch disco.ethz.ch`. Then, you can find the IP address of `disco.ethz.ch` in the answer section.
- d) Using the command `dig disco.ethz.ch`, we ask our local resolver for the IP address of `disco.ethz.ch`, which probably does not know it yet. The local resolver will then automatically perform the steps we just did by hand, and return the result to the client. The IP address that is returned is the same.

5.3 DNS Caching

- a) Just issue any `dig` request, and look at the bottom of the output. The `SERVER` field tells you the IP address of your standard resolver. This could for example be the router in your home network.
- b) Since we are issuing a non-recursive query, the default name server can only return the result to us, if it has previously been cached. Therefore, if the name server's reply does not contain an *ANSWER SECTION*, it means that the query was not cached. If we then perform a standard recursive query, we get a response with an *ANSWER SECTION*. Now we can issue another non-recursive query, which will then also provide us with a response with an *ANSWER SECTION* containing the IP address we were looking for, since the query has now been cached.
- c) Cached queries are much faster. In our case, the recursive query without cache-hit took 53 ms, and the iterative query with cache-hit only 5 ms.
- d) First, query the authoritative nameserver with `dig -t ns server.domain.tld`, then ask the authoritative nameserver to resolve the domain name.² This can for instance be useful when you configure your own server and want to test the configuration without waiting before the DNS caches are refreshed.

²This assumes that the nameserver has a fixed IP address. If not, you have to work your way up to a root nameserver and start resolving from there.