Computer Networks
WS20/21

Exercise 2

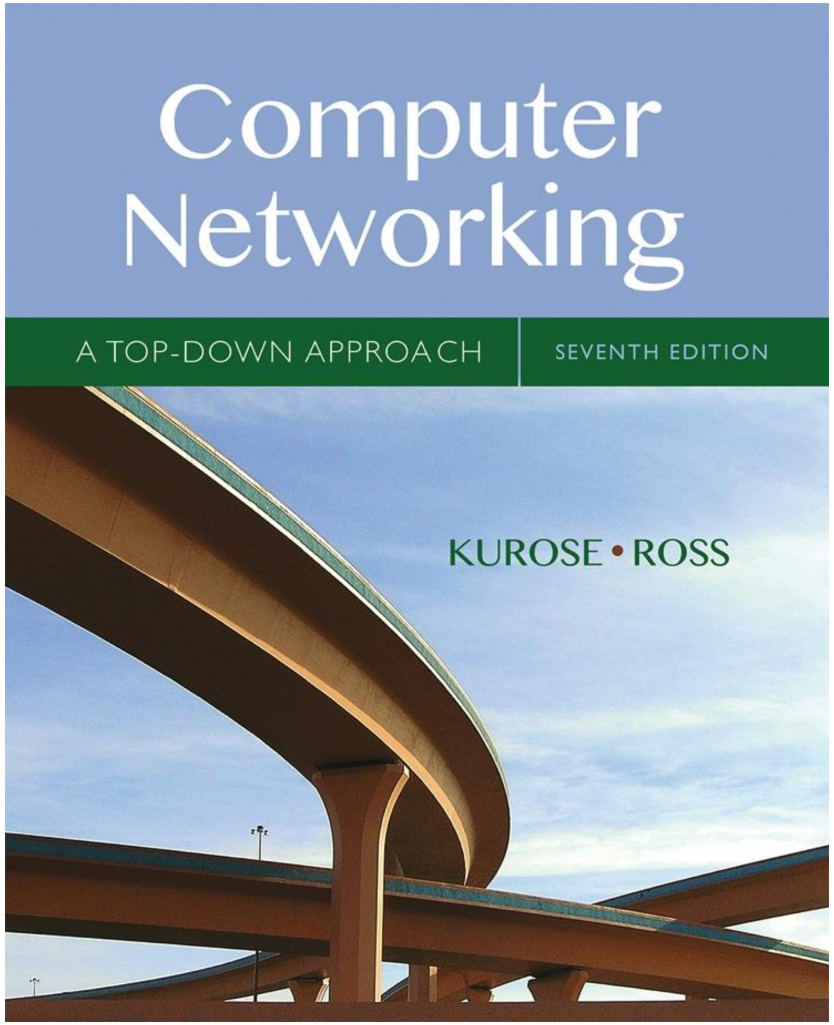
Recommendation

Try to borrow (or buy) this book:

Computer Networking: A Top Down Approach

7^{th} edition. Jim Kurose, Keith Ross, Pearson, 2019.

It is very good to understand!



Q1

True or false?

- a. A user requests a Web page that consists of some text and three images. For this page, the client will send one request message and receive four response messages.
- b. Two distinct Web pages (for example, www.mit.edu/research.html and www.mit.edu/students.html) can be sent over the same persistent connection.
- c. With nonpersistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages.
- d. The *Date:* header in the HTTP response message indicates when the object in the response was last modified.
- e. HTTP response messages never have an empty message body.

1. HTTP

- a. False: After the client received the html file with the text from its first request, it will be parsed and the three images are found. After that for each image a new request message must be sent to the server. So the client has to send four request messages
- b. True: The objects *research.html* and *students.html* are stored at the same host (*www.mit.edu*). With a persistent connection, multiple objetcs can be sent.
- c. False: In a nonpersistent connection, only one HTTP request message can be carried by a TCP segment.
- d. False: The *Date:* header indicates the time the HTTP response message was sent. The time an object was last modified is indicated by the *Last-Modified:* header.
- e. False: HTTP response messages can be empty, e.g. when the request message could not be understood by the server or the document could not be found on the server

Q2

Consider an e-commerce site that wants to keep a purchase record for each of its customers. Describe how this can be done with cookies.

2. Cookies

1. Each customer client sends an initial HTTP request message to the server
2. The server creates an ID in its database for this client
3. The server puts the ID as cookie number in the HTTP response message to the client
4. The cookie is stored in the customers web client
5. In each following HTTP message (which can contain purchases) of the client, the cookie number will be sent to the server
6. The server can re-identify the customer by the cookie number and store the purchases to the regarding ID in the database

Q3

Describe how Web caching can reduce the delay in receiving a requested object. Will Web caching reduce the delay for all objects requested by a user or for only some of the objects? Why?

3. Web cache

- A web cache is a proxy server located between client and server
- Web clients can be configured to point to a (local) cache and send all requests to this cache
- If requested object is in cache, the cache sends it to the client. The shorter distance results in a reduced delay for this object
- If requested object is *not* in cache, the web cache requests it from the server, stores it and sends it to the client. The delay is *not* reduced for this object

Q4

- Consider distributing a file of F=15 Gbits to N peers. The server has an upload rate of us=30 Mbps, and each peer has a download rate of di=2 Mbps and an upload rate of u. For N=10 and 100 and u = 300 Kbps and 2 Mbps, prepare a chart giving the minimum distribution time for each of the combinations of N and u for both client-server distribution and P2P distribution.

4. Distribution Time Client-Server

- Client-Server:

time to distribute F to N clients using client-server approach	$D_{c\text{-}s} \geq max\{NF/u_{s,}, F/d_{min}\}$

  - Upload rate u of users do not play a role
  - Download rate is the same for all users => $d_{min} = d_i$
- For N=10:

$$D_{c\text{-}s} > max\{10*15 \text{ Gb} / 30 \text{ Mb/s} , 15 \text{ Gb} / 2 \text{ Mb/s}\}$$

$$\Leftrightarrow \quad D_{c\text{-}s} > max\{10*15*10\hat{}9 \text{ b} / 30*10\hat{}6 \text{ b/s} , 15*10\hat{}9 \text{ b} / 2*10\hat{}6 \text{ b/s}\}$$

$$\Leftrightarrow \quad D_{c\text{-}s} > max\{5000s , 7500s\}$$

$$\Leftrightarrow \quad D_{c\text{-}s} > 7500s$$

4. Distribution Time P2P

- P2P:

time to distribute F to N clients using P2P approach

$$D_{P2P} \geq max\{F/u_{s,}, F/d_{min,}, NF/(u_s + \Sigma u_i)\}$$

  - Download rate is the same for all users => $d_{min} = d_i$
  - Upload rate is the same for all users => $\Sigma u_i = \Sigma u$ = N*u
- For N=10, u=300 Kbps:

$D_{P2P} > max\{15\ Gb / 30\ Mb/s\ ,\ 15\ Gb / 2\ Mb/s,\ 10*15\ Gb / (30\ Mb/s + 10*300\ Kb/s)\}$

⬄ $D_{P2P} > max\{500s\ ,\ 7500s,\ 10*15*10\text{^}9\ b /(30*10\text{^}6\ b/s + 10*300*10\text{^}3\ b/s)\}$

⬄ $D_{P2P} > max\{500s\ ,\ 7500s,\ 10*15*10\text{^}9\ b /(30*10\text{^}6\ b/s + 3*10\text{^}6\ b/s)\}$

⬄ $D_{P2P} > max\{500s\ ,\ 7500s,\ 15*10\text{^}4b / 33\ b/s\}$

⬄ $D_{P2P} > max\{500s\ ,\ 7500s,\ 4545s\} = 7500s$

4. Distribution Time

- Client-Server:

N	
10	7,500 s
100	50,000 s

- P2P:

N \ u	300 Kbps	2Mbps
10	7500 s	7500 s
100	45.454 s	7500 s

Q5

- Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose that n DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of RTT1,. . .,RTTn. Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let RTT0 denote the RTT between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object? Does it make a difference whether the IP is obtained by an iterated or a recursive query?

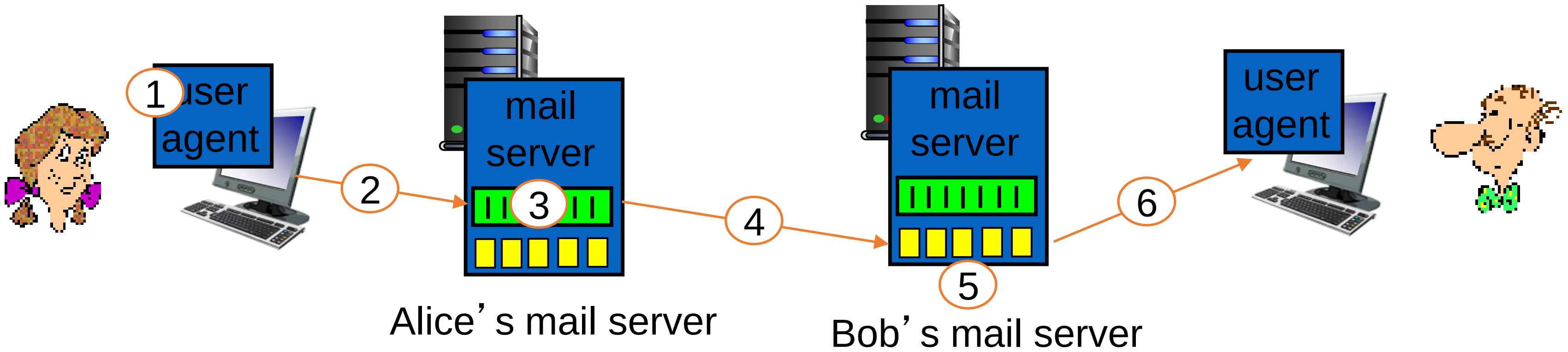
5. DNS

- $$\underbrace{RTT_1 + RTT_2 + \cdots + RTT_n}_{\text{RTTs of the successive DNS queries}} + \underbrace{RTT_0}_{\text{RTT to send the object}} = \sum_{i=0}^{n} RTT_i$$

- Iterated query:
  - If contacted name server does not know IP -> replies with a name of another server to contact
- Recursive query:
  - If contacted name server does not know IP -> asks another server by itself for the IP
- The time elapsed are the same with iterated query and recursive query! The order of the n DNS lookups does not affect the time!

Q6

- Put these actions into the right order:
  - Alice uses UA to compose message "to" `bob@someschool.edu`
  - Bob invokes his user agent to read message
  - SMTP client sends Alice's message over the TCP connection
  - Client side of SMTP opens TCP connection with Bob's mail server
  - Alice's UA sends message to her mail server; message placed in message queue
  - Bob's mail server places the message in Bob's mailbox



6. Mail protocols

- Put these actions into the right order:

1) Alice uses UA to compose message “to” `bob@someschool.edu`

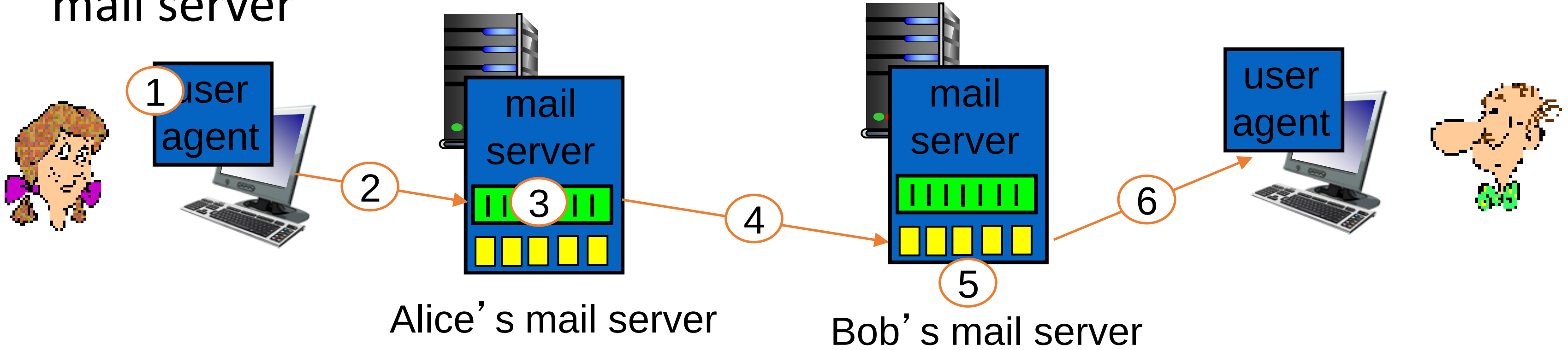
2) Alice’s UA sends message to her mail server; message placed in message queue

3) client side of SMTP opens TCP connection with Bob’s mail server

4) SMTP client sends Alice’s message over the TCP connection

5) Bob’s mail server places the message in Bob’s mailbox

6) Bob invokes his user agent to read message



Any Questions?

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