



LES REGLENE FØR DU STARTER!  
READ THE RULES BEFORE YOU START!

Skriv studentnummeret ditt her ⇨⇨

Write your student's number here ⇨

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## 1.1

Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False
1.1.1... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.1.2... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.1.3... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.1.4... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.1.5... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>
1.1.6... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.1.7... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.1.8... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.1.9... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.1.10 <input type="checkbox"/>	..... <input checked="" type="checkbox"/>

## 1.2

Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False
1.2.1... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.2.2... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.2.3... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.2.4... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.2.5... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>
1.2.6... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.2.7... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.2.8... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.2.9... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.2.10 <input checked="" type="checkbox"/>	..... <input type="checkbox"/>

## 1.3

Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False
1.3.1... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.3.2... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.3.3... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.3.4... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.3.5... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>
1.3.6... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.3.7... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.3.8... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.3.9... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.3.10 <input checked="" type="checkbox"/>	..... <input type="checkbox"/>

## 1.4

Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False
1.4.1... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.4.2... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.4.3... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.4.4... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.4.5... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>
1.4.6... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.4.7... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.4.8... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.4.9... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.4.10 <input checked="" type="checkbox"/>	..... <input type="checkbox"/>

## 1.5

Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False	Riktig True	Galt False
1.5.1... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.5.2... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.5.3... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.5.4... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.5.5... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>
1.5.6... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.5.7... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.5.8... <input type="checkbox"/>	..... <input checked="" type="checkbox"/>	1.5.9... <input checked="" type="checkbox"/>	..... <input type="checkbox"/>	1.5.10 <input checked="" type="checkbox"/>	..... <input type="checkbox"/>

Kontroller:	Eksamensvaktens signature / Invigilator's signature
<ul style="list-style-type: none"> <li>• Studentnr. på alle sider</li> <li>• Samme studentnr. over alt</li> </ul>	



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2.

**Application Layer tasks:** Depending on application layer applications, the list can be very long, e.g. ftp, email, http, p2p, streaming, IP-phone, etc, and tasks involved in each such applications.

**Transport Layer tasks:** connection set-up, flow control, congestion control, etc in TCP; segmentation, error checking, etc. In UDP

**Network Layer tasks:** forwarding, routing, datagram formating, packet handling / scheduling, error reporting, router signaling, etc. (e.g. see Figure 4.12.)

**Link Layer tasks:** framing, link access, flow control, error detection, error correction, etc. (e.g. see Pages 470-471)



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3.

### 3.1 (c.f. P.129 and Figure 2.7)

The total amount of time to get the IP address is

$$rtt_1 + rtt_2 + rtt_3.$$

Once the IP address is known,  $rtt_0$  elapses to set up the TCP connection and another  $rtt_0$  elapses to request and receive the small object (typically the webpage). The total response time is hence

$$2rtt_0 + rtt_1 + rtt_2 + rtt_3$$

### 3.2 (c.f. P.129 and Figure 2.7)

The time to get the IP address is the same as above, which is  $rtt_1 + rtt_2 + rtt_3$ .

For the first object (the webpage), after the IP address is known, it takes  $rtt_0$  to set up a TCP connection and another  $rtt_0$  to request and receive the first object, where the client extracts and finds references to the other 2 objects. So, for the first object, it takes  $2rtt_0$  for the client to receive.

For the other 2 objects, the client will take  $2rtt_0$  for each. Since parallel TCP connections are used, the minimum time is then  $2rtt_0$ .

Combining above, The total response time is hence

$$rtt_1 + rtt_2 + rtt_3 + 2rtt_0 + 2rtt_0$$

### 3.3 (c.f. P.131)

The time to get the IP address is the same as above, which is  $rtt_1 + rtt_2 + rtt_3$ .

For the first object (the webpage), after the IP address is known, it takes  $rtt_0$  to set up a TCP connection and another  $rtt_0$  to request and receive the first object, where the client extracts and finds references to the other 2 objects. So, for the first object, it takes  $2rtt_0$  for the client to receive.

For the other 2 objects, their requests can be made back-to-back (c. P.131), without waiting for replies to pending requests. The server sends the 2 objects back-to-back. Here, the communication makes use of the existing TCP connection (because of persistent HTTP). Hence, only one round trip time is needed for the other 2 objects, which is  $rtt_0$ .

Combining above, The total response time is hence

$$rtt_1 + rtt_2 + rtt_3 + 2rtt_0 + rtt_0$$





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5.

5.1: 19

5.2: Varying queuing delay in routers on the round trip path between the source host and a router.

The round trip delay is determined by processing delay, propagation delay, transmission delay, and queuing delay at each node on the round trip path. While the first three delays may be considered unchanged in each experiment, the queuing delay may change dramatically between experiments. (Another small chance possibility is that the probing packet in each experiment goes through different round trip path.)

5.3: Same as 5.2.

5.4: 154.54.0.0/18

(In a rough CIDR fashion, it may be written as 154.54.0.0/17, or 154.54.0.0/16.)



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6.

6.1: While in infrastructure mode hosts are associated with (/ connected to) a base station, the wireless hosts have no infrastructure with which to connect. (c.f. P.553)

6.2: In CSMA/CD, a station begins transmitting as soon as the channel is sensed idle, while in CSMA/CA, the station refrains from transmitting while counting down, even when it sense the channel to be idle. (c.f. P.570)

6.3: In wireless LANs e.g. 802.11, it is difficult to detect collision due to that the received signal strength is overwhelmed by local transmission strength. (c.f. Slide 5-35)

6.4: As long as the given reasons are solid, both TCP and UDP may be used in the two cases. However, for streaming stored video, TCP can be better in the sense of providing more reliable transmission; for streaming real-time video, UDP is normally preferred due to that UDP has better delay performance than TCP (because of not requiring re-transmission for reliability.)

6.5: Packets 3, 4, 6, and 7 will not arrive in time for playout, neither is packet 8.

6.6: If the first packet is played out at time 10 (or later), all packets will arrive in time for playout. Hence, the **minimum** playout delay is 2.

