

IK1203

Networks and Communication

Recitation 1 – Introduction and Application Layer

Solutions

1. Short questions:

- a) A communication protocol is an agreement between communicating parties defining the rules for communication.
- b) Application: HTTP, FTP.
Transport: TCP, UDP.
Network: IP, Routing.
Link: Ethernet, IEEE 802.11 WLAN.
Physical: Bit coding, TP Category 6.
- c) The link layer.
- d) "Routing" is about selecting a route (or path) – when the switches (routers) decide which path a packet should take through the network. "Forwarding" is when a switch (router) redirects a packet from an incoming port to an outgoing port.
- e) The transport layer provides the services of transferring data from a process on one computer (host) to a process on another computer (end-to-end delivery).

2. In the first step, the sending e-mail client sends the message via SMTP to the local server for outgoing e-mail (Message Transfer Agent). Second, the e-post message is sent from the server for outgoing e-mail to the recipient's server for incoming e-mail. This step also uses SMTP. Finally, in the third step, the recipient uses a protocol for e-mail access, such as POP or IMAP, to collect the e-mail message from the server for incoming e-mail.

3.

- a) SMTP
- b) The communication between the client and the server includes a number of handshakes. In each handshake, the client sends a command to the server and waits for a response. Each handshake takes $2 \times 2.5 \text{ ms} = 5 \text{ ms}$. A complete transfer to the outgoing server involves the following handshakes:
 - "HELO", "MAIL FROM", "RCPT TO", "DATA", the actual e-mail message, "QUIT"All in all, the transfer takes 30 ms.
- c) RCPT TO adds a recipient for the message. Hence, there is one handshake for each recipient. So 45 ms total.

4. Yes, it is possible. According to the SMTP standard, this is solved by replacing any period at the beginning of a line with two periods. The SMTP receiver will change back to a single period.

5. HTTP-request/response:

- a) <http://www.kth.se/>

- b) Yes, it was successful. The answer is "200 OK".
- c) Content-Length gives the size of "entity-body", in other words, the data portion of the response: 60044 byte.
- d) The client asks for a "persistent connection", meaning that the TCP connection should remain open so that the client can send more HTTP requests over the same connection. The server does not accept, and wants to close the TCP connection directly after the HTTP response.
- e) The five first characters of the returned object are: "<html".

Problems from course book (Kurose and Ross, 7th ed)

P2.

At time $N*(L/R)$ the first packet has reached the destination, the second packet is stored in the last router, the third packet is stored in the next-to-last router, etc. At time $N*(L/R) + L/R$, the second packet has reached the destination, the third packet is stored in the last router, etc. Continuing with this logic, we see that at time $N*(L/R) + (P-1)*(L/R) = (N+P-1)*(L/R)$ all packets have reached the destination.

P6.

- a. $d_{\text{prop}} = m/s$ seconds.
- b. $d_{\text{trans}} = L/R$ seconds.
- c. $d_{\text{end-to-end}} = d_{\text{prop}} + d_{\text{trans}} = (m/s + L/R)$ seconds
- d. The bit is just leaving Host A.
- e. The first bit is in the link and has not reached Host B.
- f. The first bit has reached Host B.
- g. Want
 $m = (L/R)*s = (120/56*10^3)*2.5*10^8 = 536 \text{ km}$

P7.

Consider the first bit in a packet. Before this bit can be transmitted, all of the bits in the packet must be generated. This requires $56*8/(64*10^3) = 7 \text{ ms}$.

The time required to transmit the packet is $56*8/(2*10^6) = 224 \mu\text{s}$

Propagation delay = 10 ms.

The delay until decoding is

$7 \text{ ms} + 224 \mu\text{s} + 10 \text{ ms} = 17.224 \text{ ms}$

A similar analysis shows that all bits experience a delay of 17.224 ms.

P10.

The first bit sent by the host with the lowest propagation delay reaches Router A after 2 ms while the last bit of the packet arrives after $2*10^{-3} + 1500*8/(4*10^6) \text{ s} = 5 \text{ ms}$.

The first bit sent by the host with the highest propagation delay reaches Router A after 6 ms. At that time the packet sent by the other host is already fully received by the router, so no queuing delay occurs.

P11.

Assume $d_1 < d_2$. No buffering occurs when $d_2 > d_1 + L/R_1$.

P13.

- a. The queuing delay is 0 for the first transmitted packet, L/R , for the second transmitted packet, and generally, $(n-1)*L/R$ for the n^{th} transmitted packet. Thus, the average delay for the N packets is:

$$\begin{aligned}
& (L/R + 2L/R + \dots + (N-1)L/R)/N \\
&= L/(RN) * (1 + 2 + \dots + (N-1)) \\
&= L/(RN) * N(N-1)/2 \\
&= LN(N-1)/(2RN) \\
&= (N-1)L/(2R)
\end{aligned}$$

Note that here we used the well-known fact:

$$1 + 2 + \dots + N = N(N+1)/2$$

- b. It takes NL/R seconds to transmit the N packets. Thus, the buffer is empty when each batch of N packets arrive. Thus, the average delay of a packet across all batches is the average delay within one batch, i.e., $(N-1)L/2R$.