IK1203
Networks and Communication

Recitation 1 – Introduction and Application Layer

1. Answer he following short questions.
   a) What is a communication protocol?
   b) Name the different layers in the Internet protocol stack, and place the following protocols/functions/concepts at the correct layer: IP, TCP, Ethernet, HTTP, bit coding, FTP, IEEE 802.11 WLAN, TP Category 6, Routing, UDP.
   c) What layer in the Internet protocol stack is responsible for the transfer of a data packet over a single link, between two directly connected devices?
   d) A router has two main functions, which can be described by the two terms "routing" and "forwarding". What is the difference between routing and forwarding?
   e) What service does the transport layer describe? Give a short answer.

2. Describe shortly how an e-mail message in sent from a sending to a receiving e-mail client (user agent), such as MS Outlook or Mozilla Thunderbird. From the description, it should be clear what application protocols and what systems are involved in the transfer.

3. An e-mail message is sent from an e-mail client (MUA) to a server for outgoing e-mail.
   a) Which protocol is used for the transfer?
   b) The communication delay between the client and the server is 2.5 milliseconds (in other words, it takes 2.5 milliseconds from that the sender has started sending the message until the complete message has reached the receiver). How long time does it take before the entire transfer of the e-mail message to the outgoing server has been completed? The time it takes to set up and tear down a TCP connection should not be included in the calculation. The message has one recipient.
   c) Suppose that the message has four recipients. How long time does it take then?

4. According to the SMTP protocol, the end of the message is indicated by a line with only a single period '.' Does that mean that it is not possible to send an e-mail message that contains a line with a single period? Explain!

5. Suppose that the following request is sent to an HTTP server:

```
GET / HTTP/1.1
Host: www.kth.se
Connection: keep-alive
```

The answer is:

```
HTTP/1.1 200 OK
Date: Mon, 26 Jan 2015 21:42:31 GMT
Server: Apache/2.2.15 (Red Hat)
Set-Cookie: JSESSIONID=00DFBC112EABCE74FAB714A56ABF3282; Path=/; Secure; HttpOnly
Content-Language: sv-SE
Content-Length: 60044
Connection: close
Content-Type: text/html;charset=UTF-8

<html>
<head>
<title>KTH | Välkommen till KTH</title>
```

A lot of information removed...

Answer the following questions:

a) What is the complete URL for the requested object?
b) Was the request successful?
c) How large is the requested object?
d) Explain the header field "Connection:" that appears both in the request and in the response. What does the client want, and what is the response from the server?
e) What are the first five characters in the returned object?

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

Chapter 1

P2.
Equation 1.1, $d_{\text{end-to-end}} = N*(L/R)$, gives a formula for the end-to-end delay of sending one packet of length L over N links of transmission rate R. Generalize this formula for sending P such packets back-to-back over the N links.

P6.
This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.

a. Express the propagation delay, d_{prop}, in terms of m and s.
b. Determine the transmission time of the packet, d_{trans}, in terms of L and R.
c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.
d. Suppose Host A begins to transmit the packet at time $t = 0$. At time $t = d_{\text{trans}}$, where is the last bit of the packet?
e. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{\text{trans}}$, where is the first bit of the packet?
f. Suppose d_{prop} is less than d_{trans}. At time $t = d_{\text{trans}}$, where is the first bit of the packet?
g. Suppose $s = 2.5*10^8$, $L = 120$ bits, and $R = 56$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

P7.
In this problem, we consider sending real-time voice from Host A to Host B over a packet-switched network (VoIP). Host A converts analog voice to a digital 64 kbps bit stream on the fly. Host A then groups the bits into 56-byte packets. There is one link between Hosts A and B; its transmission rate is 2 Mbps and its propagation delay is 10 msec. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)?

P10.
Consider the network illustrated in Figure 1.16 (below). Assume the two hosts on the left of the figure start transmitting packets of 1500 bytes at the same time towards Router B. Suppose the link rates between the hosts and Router A is 4 Mbps. One link has a 6 ms propagation delay and the other has a 2 ms propagation delay. Will queuing delay occur at Router A?

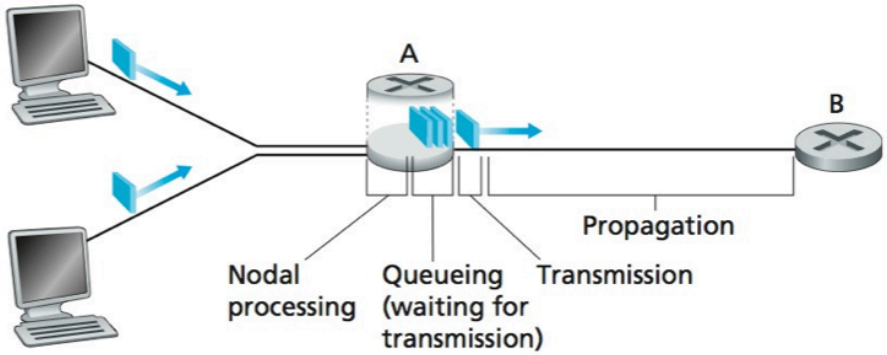

Figure 1.16 ♦ The nodal delay at router A

P11.
Consider the scenario in Problem P10 again, but now assume the links between the hosts and Router A have different rates R_1 and R_2 byte/s in addition to different propagation delays d_1 and d_2. Assume the packet lengths for the two hosts are of L bytes. For what values of the propagation delay will no queuing delay occur at Router A?

P13.

a. Suppose N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. What is the average queuing delay for the N packets?
b. Now suppose that N such packets arrive to the link every NL/R seconds. What is the average queuing delay of a packet?