Answers to quiz #1 of introduction to networking

Christian Rinderknecht

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1 Review questions

1. *What is the difference between a host and an end system? List different types of end systems. Is a mail server an end system?*

   There is no difference. Some hosts are workstations, PCs, mail servers, Web servers, etc.

2. *What is a client program? What is a server program?*

   A networking application is usually made of two parts of software, each running on a different host. The one which requests some services to the other is called the client. The other is the server.

3. *What are the two kinds of services that the Internet provides to the applications? Describe some typical features of each.*

   The Internet provides a connection-oriented service, called TCP, and a connectionless service, called UDP, to the applications. The principles of TCP are

   - The two end systems perform a handshaking before starting a session;
   - It provides reliable end-to-end transport, i.e. the data is guaranteed to be delivered completely and in order.
   - It provides flow control, i.e. ensures that no end system will overwhelm the other by sending to fast too many data,
   - It provides congestion control, i.e. makes sure that the end systems will not overflow the buffers of the routers in the network.

   Connectionless services like UDP do not guarantee anything above.

4. *Are the objectives of flow control and congestion control the same?*

   No, their objectives are different. Flow control is about a host not overflowing the other host's receiving buffer, whilst congestion control is about not overflowing the router's queues.

5. *Give a very short description of how the connection-oriented service of the Internet provides reliable transport. What is the name of this service, by the way?*

   This service is TCP. It ensures reliable transport by means of acknowledgement and retransmission. If the sender does not receive the acknowledgement from the destination about a given packet, then this packet is transmitted again.

6. *Suppose there is exactly one packet switch between a sending host and a receiving host. The transmission rates between the sending host and the switch and between the switch and the receiving host are R_1 and R_2, respectively. Assuming that the switch uses store-and-forward packet switching, what is the total end-to-end delay to send a packet of length L? (Ignore queuing, propagation delay and processing delay.)*

   At time t_0 the sending hosts starts to transmit the packet. At time $t_1 = L/R_1$, the entire packet is transmitted and received by the router (no propagation delay). At time $t_2 = t_1 + L/R_2$ the packet is transmitted by the router and received by the destination (again, no propagation delay). Thus the end-to-end delay is $L(1/R_1 + 1/R_2)$.

2 Problems

1. *Design and describe an application-level protocol to be used between an automatic teller machine (ATM) and a bank's centralised computer. Your protocol should allow a user's card and password to be verified, the account balance (which is maintained at the bank's centralised computer) to be queried, and an account withdrawal to be made (money is given to the customer).*

   Specify your protocol by listing the messages exchanged and the action taken by the ATM or the bank's centralised computer on transmission or receipt of each message.

   Sketch the operation of your protocol for the case of a simple withdrawal with no errors, using a diagram similar to Figure 1. Explicitly state the assumptions made by your protocol about the underlying end-to-end transport service.

   One example is as follows.

   Messages from ATM to server:

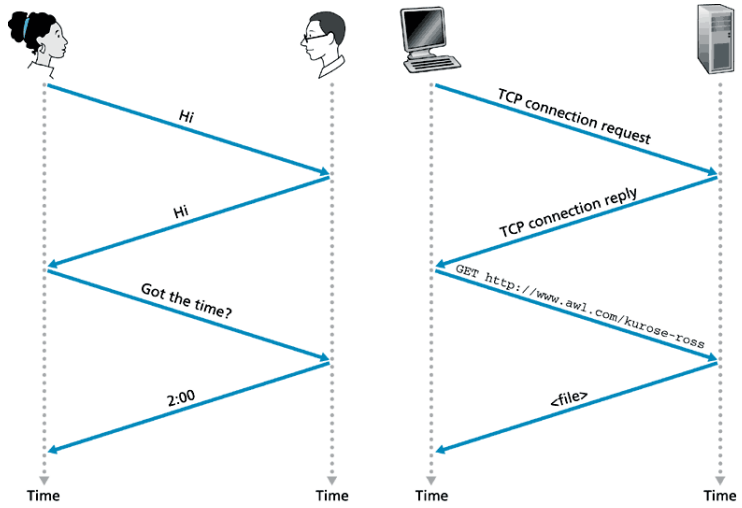

Figure 1: Sketch of protocols

Message name	Purpose
HELO <userid>	Let server know that there is a card in the ATM, then transmits user ID to server
PASSWD <passwd>	User enters PIN, which is sent to server
BALANCE	User requests balance
WITHDRAWAL <amount>	User asks to withdraw money
BYE	User all done

Messages from server to ATM (display):

Message name	Purpose
PASSWD	Ask user for PIN (password)
OK	Last requested operation (PASSWD, WITHDRAWAL) OK
ERR	Last requested operation (PASSWD, WITHDRAWAL) resulted in error
AMOUNT <amount>	Sent in response to BALANCE request
BYE	User done, display welcome screen at ATM

A correct withdrawal looks like this:

```
HELO <userid>       ------------> (Check if valid userid)
                    <------------ PASSWD
PASSWD <passwd>     ------------> (Check password)
                    <------------ OK (password is OK)
```

```
BALANCE              ------------->
                     <------------- AMOUNT <amount>
WITHDRAWAL <amount>  -------------> (Check if enough money)
                     <------------- OK
ATM dispenses money
BYE                  ------------->
                     <------------- BYE
```

2. *Consider an application that transmits data at a steady rate: it generates an N-bit unit of data every k time units, where k is small and fixed. Also, when such an application starts, it will continue running for a long period of time. Answer the following questions, briefly justifying your answer.*

   (a) *Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?*

   A circuit-switched network would be well suited to this application, because it involves long sessions with predictable bandwidth requirements. So bandwidth can be reserved for each session. The delay of setting up a circuit is low compared to the time the application is running.

   (b) *Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?*

   Given such generous link capacities, the network need no congestion control. In the worst case, all the applications are emitting on the same link, but the link offers enough bandwidth.