Problem 7

The total amount of time to get the IP address is

$$RTT_1 + RTT_2 + \Lambda + RTT_n .$$

Once the IP address is known, RTT_O elapses to set up the TCP connection and another RTT_O elapses to request and receive the small object. The total response time is

$$2RTT_o + RTT_1 + RTT_2 + \Lambda + RTT_n$$

Problem 8

a)

$$RTT_1 + \Lambda + RTT_n + 2RTT_o + 3 \cdot 2RTT_o$$
$$= 8RTT_o + RTT_1 + \Lambda + RTT_n .$$

b)

$$RTT_1 + \Lambda + RTT_n + 2RTT_o + 2RTT_o$$
$$= 4RTT_o + RTT_1 + \Lambda + RTT_n .$$

c)

$$RTT_1 + \Lambda + RTT_n + 2RTT_o + RTT_o$$

$$= 3RTT_o + RTT_1 + \Lambda + RTT_n .$$

Problem 21

a) The advantage of sending the QueryHit message directly over a TCP connection from Bob to Alice is that the QueryHit message is routed by the underlying Internet without passing through intermediate peers; thus, the delay in sending the message from Bob to Alice should be substantially less. The disadvantage is that each peer that has a match would ask Alice to open a TCP connection; Alice may therefore have to opens tens or hundreds of TCP connections for a given query. Furthermore, there will be additional complications if Alice is behind a NAT (see Chapter 4).

b) When a QueryHit message enters a peer, the peer records in a table the MessageID along with an identifier of the TCP socket from which the message arrived. When the same peer receives a QueryHit message with the same MessageID, it indexes the table and determines the socket to which it should forward the message.

c) When the Query message reaches Bob, it contains an ordered list of all the IP addresses of the peers the message passed through between Alice and Bob. When Bob sends back a QueryHit message, it would copy the ordered list into the message. When a peer receives the QueryHit message, it can use the list to determine the next peer in the reverse path.

Problem 23

Alice sends her query to at most N neighbors. Each of these neighbors forwards the query to at most $M = N-1$ neighbors. Each of those neighbors forwards the query to at most M neighbors. Thus the maximum number of query messages is

$$N + NM + NM^2 + \dots + NM^{(K-1)}$$
$$= N(1 + M + M^2 + \dots + M^{(K-1)})$$
$$= N(1-M^K)/(1-M)$$
$$= N[(N-1)^K - 1]/(N-2)$$