Problem 1. Consider the following string of ASCII characters that were captured by Wireshark when the browser sent an **HTTP GET** message (i.e., this is the actual content of an **HTTP GET** message). The characters **<cr><lf>** are carriage return and line-feed characters (that is, the italized character string **<cr>** in the text below represents the single carriage-return character that was contained at that point in the HTTP header). Answer the following questions, indicating where in the **HTTP GET** message below you find the answer.

```
GET /cs453/index.html HTTP/1.1<cr><lf>Host:gaia.cs.umass.edu<cr><lf>
User-Agent: Mozilla/5.0 ( Windows;U; Windows NT 5.1; en-US; rv:1.7.2)
Gecko/20040804 Netscape/7.2 (ax) <cr><lf> Accept:ext/xml,
application/xml, application/xhtml+xml, text /html;q=0.9,
text/plain;q=0.8,image/png,*/*;q=0.5
<cr><lf>Accept-Language: en-us,en;q=0.5<cr><lf>Accept-Encoding:
zip,deflate<cr><lf>Accept-Charset: ISO-8859-
1,utf8;q=0.7,*;q=0.7<cr><lf>Keep-Alive: 300<cr><lf>
Connection:keepalive<cr><lf><cr><lf>
```

a. What is the URL of the document requested by the browser?
b. What version of HTTP is the browser running?
c. Does the browser request a non-persistent or a persistent connection?
d. What is the IP address of the host on which the browser is running?
e. What type of browser initiates this message? Why is the browser type needed in an HTTP request message?

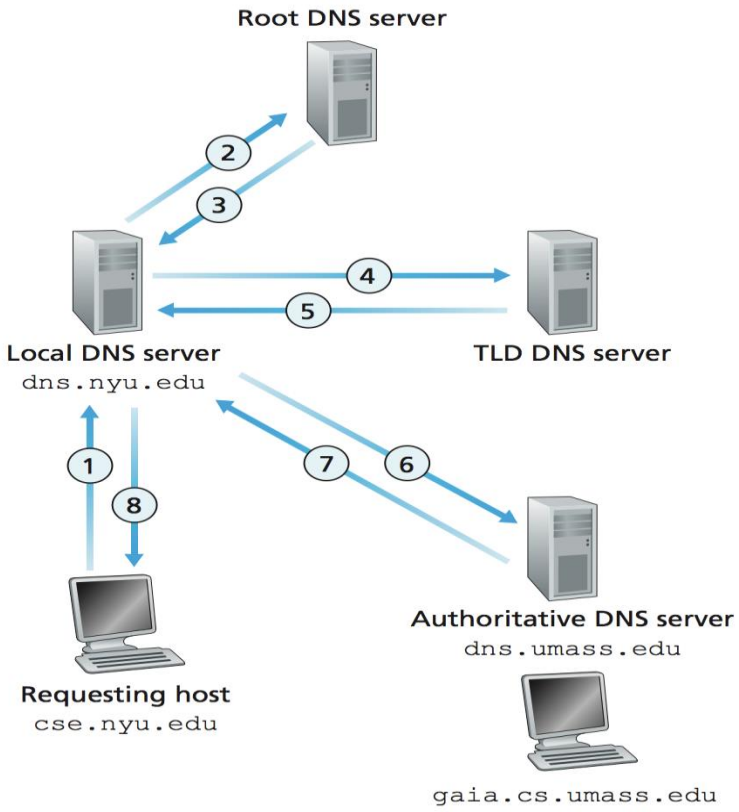
Problem 2. Assume that the RTT between a client and the local DNS server is $\mathbf{RTT_L}$, while the RTT between the local DNS server and other DNS servers is $\mathbf{RTT_r}$. Assume that no DNS server performs caching.

a. What is the total response time for the scenario illustrated in the following Figure?

A) RTT_L
B) $RTT_L + RTT_r$
C) $RTT_L + 2RTT_r$
D) $RTT_L + 3RTT_r$

b. Assume now that the DNS record for the requested name is cached at the local DNS server. What is the total response time?

A) RTT_L
B) $RTT_L + RTT_r$
C) $RTT_L + 2RTT_r$
D) $RTT_L + 3RTT_r$



Problem 3. Suppose within your browser you type in a URL to obtain a webpage. The IP address for the associated URL is not cached in your local host, so as DNS lookup is necessary to obtain the IP address. Suppose that n DNS servers are visited before your host receives the IP address from DNS; Visiting the i-th of the them incurs an RTT_i per DNS. Further suppose the HTML file references eight very small objects on the same server. Let RTT_0 denote the RTT between the local host and the server containing an object. Neglecting transmission times, how much time elapses with

a. Non-persistent HTTP with no parallel TCP connections?

A) $RTT_1 + \ldots + RTT_n + 8RTT_0$
B) $RTT_1 + \ldots + RTT_n + 9RTT_0$
C) $RTT_1 + \ldots + RTT_n + 16RTT_0$
D) $RTT_1 + \ldots + RTT_n + 18RTT_0$

b. Non-persistent HTTP with the browser configured for 5 parallel connections?

A) $RTT_1 + \ldots + RTT_n + 4RTT_0$
B) $RTT_1 + \ldots + RTT_n + 5RTT_0$
C) $RTT_1 + \ldots + RTT_n + 6RTT_0$
D) $RTT_1 + \ldots + RTT_n + 7RTT_0$

c. Persistent HTTP?

A) $RTT_1 + \ldots + RTT_n + 8RTT_0$
B) $RTT_1 + \ldots + RTT_n + 10RTT_0$
C) $RTT_1 + \ldots + RTT_n + 12RTT_0$
D) $RTT_1 + \ldots + RTT_n + 14RTT_0$

Problem 4. (Looking up an IP address using nslookup) You can type nslookup followed by the hostname you want to look up (e.g., type “nslookup cityu.edu.hk” in the command prompt), and nslookup will issues a DNS query to find out the IP address.

a. What is the IP address of the hostname?
b. Can you type the IP address in your browser’s address bar and get to the webpage?