

## Principles of Computer Networks

### Tutorial 4

#### Problem 1

Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a 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; the successive visits incur an  $RTT$  of  $RTT_1, \dots, RTT_n$ . Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let  $RTT_0$  denote the  $RTT$  between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?

#### Problem 2

Consider distributing a file of  $F$  bits to  $N$  peers using a client-server architecture. Assume a fluid model where the server can simultaneously transmit to multiple peers, transmitting to each peer at different rates, as long as the combined rate does not exceed  $u_s$ .

- Suppose that  $u_s/N \leq d_{\min}$ . Specify a distribution scheme that has a distribution time of  $NF/u_s$ .
- Suppose that  $u_s/N \geq d_{\min}$ . Specify a distribution scheme that has a distribution time of  $F/d_{\min}$ .
- Conclude that the minimum distribution time is in general given by  $\max\{NF/u_s, F/d_{\min}\}$ .

#### Problem 3

Consider distributing a file of  $F$  bits to  $N$  peers using a P2P architecture. Assume a fluid model. For simplicity assume that  $d_{\min}$  is very large, so that peer download bandwidth is never a bottleneck.

- Suppose that  $u_s \leq (u_s + u_1 + \dots + u_N)/N$ . Specify a distribution scheme that has a distribution time of  $F/u_s$ .
- Suppose that  $u_s \geq (u_s + u_1 + \dots + u_N)/N$ . Specify a distribution scheme that has a distribution time of  $NF/(u_s + u_1 + \dots + u_N)$ .
- Conclude that the minimum distribution time is in general given by  $\max\{F/u_s, NF/(u_s + u_1 + \dots + u_N)\}$ .