Homework 2 - Solution

1. (12 points) Identify the OSI layer responsible for each of the following functionalities:
   a. Providing node-to-node communications with reliable service.

      Answer: Data link layer

   b. Determining the best path to route packets.

      Answer: Network layer.

   c. Providing end-to-end communications with reliable service.

      Answer: Transport layer

2. (8 points) Suppose that you have two browser applications open and active at the same time and that both applications are accessing the same server to retrieve HTTP documents at the same time. How does the server know how to tell the difference between the two applications (to send the correct document(s) to the correct application)?

   Answer: A client application generates an ephemeral port number for every TCP connection it sets up. An HTTP request connection is uniquely specified by the five parameters: (TCP, client IP address, ephemeral port #, server IP address, 80). The two applications in the above situations will have different ephemeral port #s and will thus be distinguishable to the server.

3. (10 points) Suppose that we want to distribute a file with a size of $F = 20$ Gbits to $N = 100$ clients/peers. The server supports an upload rate of $u_s = 30$ Mbps while each client/peer has a download rate of $d_i = 2$ Mbps and an upload rate of u, where $u = 300$ Kbps or 700 Kbps. Show your calculations.
   a. Calculate the minimum distribution time for a client-server distribution using the two values of u given above.

      Answer: For calculating minimum distribution time for client-server distribution, we use the following formula, $D_{c\text{-}s} = max\ \{NF/u_s, F/d_{min}\}$

      NF/us=(100×20×1024^3)(30×1024^2)=68266.$\bar{6}$ ≅ 68267

      F/d_{min}=(20×1024^3 / 2×1024^2)=10240

      For u=300 Kbps or 700 Kbps, the minimum distribution time remains the same.

      $D_{\text{c-s}}$ =max{NF/u_s,F/d_{min} }=max{68267,10240}=68267.

b. Calculate the minimum distribution time for a peer-to-peer distribution using the two values of u given above.

Answer: For calculating the minimum distribution time for P2P distribution, we use the following formula: $D_{p2p} = max\ (\ F/u_s, D/d_{min}, NF/u_s + \sum_{i=1}^{N} u_i)$

$U = 300\ Kbps$

$F/u_s = (20 \times 1024^3) / (30 \times 1024^2) = 682.\bar{6} \cong 683$

$F/\ d_{min} = (20 \times 1024^3 / 2 \times 1024^2\ ) = 10240$

$NF/\ u_s = (100 \times 20 \times 1024^3\ ) / (\ 30 \times 1024^2 + 100 \times 300 \times 1024) = 34538$

$D_{p2p} = max\ (\ F/u_s, D/d_{min}, NF/u_s + \sum_{i=1}^{N} u_i) = max\ (683,10240,34538) = 34538$

$U = 700\ kbps$

$F/u_s = (20 \times 1024^3) / (30 \times 1024^2) = 682.\bar{6} \cong 683$

$F/\ d_{min} = (20 \times 1024^3 / 2 \times 1024^2\ ) = 10240$

$NF/\ u_s = (100 \times 20 \times 1024^3\ ) / (\ 30 \times 1024^2 + 100 \times 700 \times 1024) = 20822$

$D_{p2p} = max\ (\ F/u_s, D/d_{min}, NF/u_s + \sum_{i=1}^{N} u_i) = max\ (683,10240,20822) = 20822$

4. (10 points) TCP/IP over Ethernet supports basic frames with a total size of up to 1518 bytes (including both the message payload and headers). Suppose that an application protocol wants to send an *L*-byte message across the network to its peer over TCP/IP. The TCP segment adds 20 bytes of header to the payload, while IP packet adds an additional 20 bytes of header to the segment. If the Ethernet frame adds 18 bytes of header to the packet, calculate the size of *L* the application needs so that exactly 95% of the transmitted bits in the physical layer carry the message payload (i.e., the data itself, not the header). Show your calculations.

Answer: Since 58 bytes of header is added (20 bytes at TCP, 20 bytes at IP, and 18 bytes at Ethernet), we want $L/(L+58) = 0.95$. Solving for *L*, we get *L*=1102 bytes.