Scarlett Jones
CSCE 3530
Homework #3
Due 10/10/2016 11:55 PM

1. Explain the working of File Transfer Protocol (FTP). Explain at least five commands that are used by FTP.
    a. FTP uses a client/server model that transfers a file to/from a remote host. FTP uses RFC 959 and the server uses port 21. FTP uses TCP for data connection. Once the client is connected to the remote host, the client can browse a remote directory and send commands. When the client asks the server for a file transfer, the server opens another TCP connection to send the file to the client. After the files has been transferred, the server closes that connection. To transfer another file, a new TCP connection would have to be opened. The control connection is out of band. The FTP server maintains its state, meaning the current directory or earlier authentication.
    b. USER username: This command allows you to input a username.
    c. PASS password: This command allows you to input a password.
    d. LIST: This command returns a list of files in the current directory.
    e. RETR filename: This command retrieves or gets a file from the server.
    f. STOR filename: This command stores or puts a file onto the remote host.
2. Explain how emails are sent using Simple Mail Transfer Protocol (SMTP).
    a. SMTP uses RFC 2821. SMTP sets up connection with TCP using port 25. A user agent sends mail to the mail server. Then that mail server uses SMTP to send the message to a different user agent's mail server. During the SMTP transfer, there is a handshake (greeting), the transfer of messages, and then closure. Messages have to be in 7-bit ASCII. SMTP only hands the delivery/storage to receiver's server. SMTP uses persistent connections. Commands are written in ASCII text and responses are written as a status code and a phrase. Outgoing and incoming messages are stored on a mail server.
3. Differentiate (at least two points) at least three protocols used to retrieve emails.
    a. POP
        i. Downloads and deletes messages
        ii. User cannot re-read email if they change client
    b. IMAP
        i. Keeps all messages in one place, at the mail server
        ii. Allows user to organize messages in folders
        iii. Keeps user state across sessions
    c. POP3
        i. Downloads and keeps copier of messages on different clients
        ii. Stateless across sessions
    d. HTTP
4. What is Domain Name System (DNS)? What are the services offered by DNS? What are the hierarchical servers in DNS?
    a. The Domain Name System is a distributed hierarchical database that is used to translate hostnames to IP addresses.
    b. Services Offered:
        i. Hostname to IP address translation
        ii. Host aliasing
        iii. Mail server aliasing

iv. Load distribution

c. Hierarchical servers:
   i. Root name servers: client asks the root servers to find the correct top level domain server first
   ii. Top level domain servers: responsible for com, org, net, edu, aero jobs, museums, and all top level country domains
   iii. Authoritative dns servers: organization's own DNS servers, which provide authoritative hostname to IP mappings for organization's named hosts
   iv. Local dns name server: does not strictly belong to the hierarchical servers, but each ISP has one

5. Discuss the working of recursive and iterative queries in DNS.
   a. Recursive Query: Puts burden of name resolution on contacted name server. Puts a heavy load at upper levels of hierarchy.
   b. Iterative Query: Contacted server replies with name of server to contact
6. A file of F = $1x10^7$ bits is distributed to N peers. The server has an upload rate of us = $10x10^5$ bps. Each peer has a download rate of di = $2x10^5$ bps and an upload rate of u = 50,000 bps. For N = 0 to 10, and for both client-server and P2P architectures, plot a single graph with minimum distribution time on the y-axis and N on the x-axis.

$$\frac{F}{u_s} = \frac{1 * 10^7 bits}{10 * 10^5 bps} = 10s$$

$$\frac{F}{d_{min}} = \frac{1 * 10^7 bits}{2 * 10^5 bps} = 50s$$

N	File transfer client-server time = $\max\left\{\frac{NF}{u_s}, \frac{F}{d_{\min}}\right\}$	File transfer P2P time = $\max\left\{\frac{F}{u_s}, \frac{F}{d_{min}}, \frac{NF}{u_s+\sum u_i}\right\}$
0	$\max\{0, 50\} = 50s$	$\max\{10, 50, 0\} = 50s$
1	$\max\{1 * 10, 50\} = 50s$	$\max\left\{10, 50, \frac{1 * 1 * 10^7}{10 * 10^5 + 1 * 50000}\right\} = \max\{10, 50, 9.52\} = 50s$
2	$\max\{2 * 10, 50\} = 50s$	$\max\left\{10, 50, \frac{2 * 1 * 10^7}{10 * 10^5 + 2 * 50000}\right\} = \max\{10, 50, 18.18\} = 50s$
3	$\max\{3 * 10, 50\} = 50s$	$\max\left\{10, 50, \frac{3 * 1 * 10^7}{10 * 10^5 + 3 * 50000}\right\} = \max\{10, 50, 26.09\} = 50s$
4	$\max\{4 * 10, 50\} = 50s$	$\max\left\{10, 50, \frac{4 * 1 * 10^7}{10 * 10^5 + 4 * 50000}\right\} = \max\{10, 50, 33.33\} = 50s$

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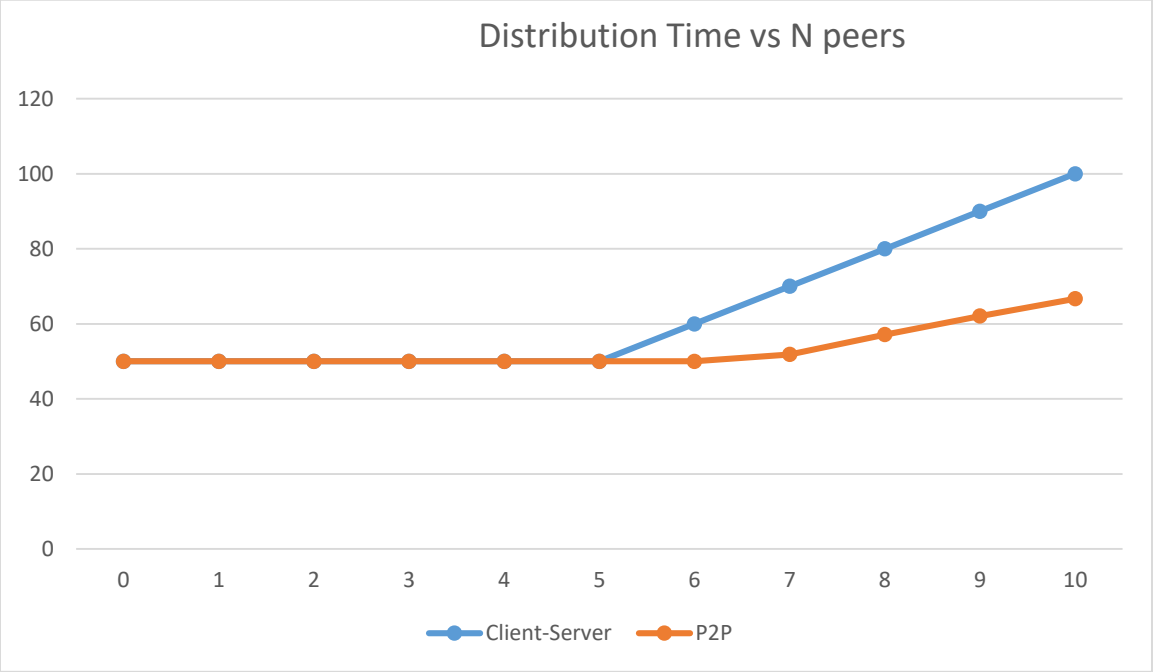
5	$\max\{5 * 10, 50\} = 50s$	$\max\left\{10, 50, \frac{5 * 1 * 10^7}{10 * 10^5 + 5 * 50000}\right\} = \max\{10, 50, 40\} = 50s$
6	$\max\{6 * 10, 50\} = 60s$	$\max\left\{10, 50, \frac{6 * 1 * 10^7}{10 * 10^5 + 6 * 50000}\right\} = \max\{10, 50, 46.15\} = 50s$
7	$\max\{7 * 10, 50\} = 70s$	$\max\left\{10, 50, \frac{7 * 1 * 10^7}{10 * 10^5 + 7 * 50000}\right\} = \max\{10, 50, 51.85\} = 51.85s$
8	$\max\{8 * 10, 50\} = 80s$	$\max\left\{10, 50, \frac{8 * 1 * 10^7}{10 * 10^5 + 8 * 50000}\right\} = \max\{10, 50, 57.14\} = 57.14s$
9	$\max\{9 * 10, 50\} = 90s$	$\max\left\{10, 50, \frac{9 * 1 * 10^7}{10 * 10^5 + 9 * 50000}\right\} = \max\{10, 50, 62.07\} = 62.07s$
10	$\max\{10 * 10, 50\} = 100s$	$\max\left\{10, 50, \frac{10 * 1 * 10^7}{10 * 10^5 + 10 * 50000}\right\} = \max\{10, 50, 66.67\} = 66.67s$



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7. Explain at least one P2P application (BitTorrent or DHT) in detail.
    a. BitTorrent
        i. File is divided into 256Kb chunks. Peers in torrent send/receive file chunks. Groups of peers exchange chunks of a files between each other. As a peer downloads a chunk, it also uploads chunks to other peers. Peer churning may occur when a peer decides to leave the torrent after it gets the file it asked for.
        ii. Different peers have different subsets of file chunks. The requester asks each peer for a list of chunks that they have periodically. The requester asks for the rarest chunks first.
        iii. Peers can have a top 4 list of the fastest transmitting peers. They look at a 5^{th} peer every 30 seconds to see if there is a faster peer to put in the top 4 peer list. Peers want the highest upload rate possible to get the file faster, so they keep the best trading partners.
8. What does the transport layer do? Name at least two transport layer protocols?
    a. Transport layer does logical communication between processes. It relies on and enhances network layer services.
    b. 2 transport layer protocols are TCP and UDP.
9. What is multiplexing and demultiplexing? How and why it is done at the transport layer?
    a. Multiplexing happens at the sender. It handles data from multiple sockets, and adds a transport header. The sender receives data from an application and encapsulates the packets with a transport layer header.
    b. Demultiplexing happens at the receiver. It uses header info from the multiplexing part to deliver received segments to the correct socket. The receiver gathers the data, examines the socket associated with the data and passes the data to the correct application.
    c. Multiplexing and demultiplexing are done at the transport layer because it is the layer right after the application layer. A socket connects the transport layer to the application layer.
    d. Multiplexing: The transport layer protocol collects the application layer messages from the processes and multiplexes and encapsulates them with the process and host and sends it to the network layer protocol.
    e. Demultiplexing: The Transport layer protocol collects all the application layer messages from the network layer protocol and demultiplexes them to determine which process should receive the application layer message.
10. Explain connectionless demultiplexing and connection-oriented demultiplexing.
    a. Connectionless demultiplexing uses UDP. This datagram needs to specify the destination IP address and the destination port number. After the host receives a UDP segement, it checks the destination port number in the segment and then directs the UDP segment to the socket with that port number. If different IP datagrams have the same destination port number, but different source IP addresses and/or different source port numbers, they will be directed to the same socket at the destination.
    b. Connection-oriented demultiplexing uses TCP. This is identified by a four-tuple: the source IP address, the source port number, the destination IP address, and the

destination port number. To demux, the receiver uses all four values to direct the data segment to the appropriate socket. Server host may support many simultaneous TCP sockets because each socket is identified by its own 4-tuple. Web server have different sockets for each connecting client. This works because non-persistent HTTP will have different sockets for each client request.

11. Explain the UDP segment fields with a structure diagram.
    a. Structure diagram

← 32 Bits →	
Source port number	Destination port number
Length	Checksum
Application data (payload)	

    b. The source port number is the port number that the sender is using.
    c. The destination port number is where the data needs to be sent to.
    d. The length is the length in bytes of the UDP segment including the header.
    e. The checksum detects errors in the transmitted segment.
    f. The application data (payload) is the data that is being sent over the UDP connection.
12. Compute the check sum for each of the following data payload.
    a. 0x1231 | 0x0003

0x1231 + 0x0003 = 0001 0010 0011 0001 + 0000 0000 0000 0011 = 0001 0010 0011 0100 (sum in binary)

One's compliment the sum to get the checksum: 1110 1101 1100 1011 (checksum in binary)

Checksum in hex: 0xEDCB

    b. 0x1232 | 0xEF23 | 0X1238 | 0x4321

0x1232 + 0xEF23 = 0001 0010 0011 0010 + 1110 1111 0010 0011 = 1 0000 0001 0101 0101

Wraparound sum: 0000 0001 0101 0101 + 1 = 0000 0001 0101 0110 (first half of sum)

0x1238 + 0x4321 = 0001 0010 0011 1000 + 0100 0011 0010 0001 = 0101 0101 0101 1001 (second half of sum)

Then sum the two halves found above: 0000 0001 0101 0110 + 0101 0101 0101 1001 = 0101 0100 1010 1111 (sum in binary)

One's compliment the sum to get the checksum

1010 1011 0101 0000 (checksum in binary)

Checksum in hex: 0xAB50