## Assignments
- Homework 10B: 9.20, 9.21, 9.24, 9.26

### 9.1 Traditional Applications
In this section we will explore two of the most popular applications on the Internet: email and the World Wide Web.

We will focus on four application protocols:

- **SMTP**: Simple Mail Transfer Protocol used to exchange electronic mail.
- **HTTP**: HyperText Transport Protocol used between web servers and browsers.
- **DNS**: Domain Name Systems used to query name servers and send responses.
- **SNMP**: Simple Network Management Protocol used to query network resources.

These protocols define the format and type of message that can be exchanged between a client and server.

For each protocol (except DNS) there is a protocol that defines the format of the data exchanged.

For example, SMTP defines the request/reply protocol used between an email client and server while RFC 822 and MIME define the format of the actual email message.

### 9.1.1 Email (SMTP, MIME, IMAP)
Email is one of the oldest network applications. To understand how email works you must distinguish (1) between the user interface and the message transfer protocol (SMTP), and (2) between the transfer protocol and the message format (RFC 822 and ____________).

We will first examine the message format.

The header is a series of <CRLF> terminated lines. Some headers are generated from user input:

To: donna@gmail.com

Subject: UE play this weekend
Other headers are generated by the mail delivery system:

From: tony@gmail.com
Date: Sat, Nov 13, 2010 at 9:23 AM

The **Received**: header(s) are particularly interesting. They will tell you where the message originated and what ______ the message took to get to you.

RFC 822 was extended (the Multipurpose Internet Mail Extensions or MIME) in 1993 and 1996 to allow email to carry different types of data: audio, video, images, etc. This was done by adding additional headers.

Some mail gateways assume email contains only 7 bit ASCII and are not 8-bit clean. Binary email data is encoded using ______ in which the 24 bits contained in 3 bytes of binary data are encoded using 4 bytes each containing a 6-bit value.

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From: Laura Rios <laura@oara.sf.ca.us>
To: steve@ntecom.za
Subject: Sara is two!
Mime-Version: 1.0
Content-Type: multipart/mixed; boundary="--------415ACD5GH889"

---------- 415ACD5GH889
Content-Type: text/enriched; charset="us-ascii"

Hi, Steve. Sara had her second birthday yesterday. Can you believe it? She is so <bold>big</bold>! Now if we can just live through the "terrible twos" for a year, <italic>sigh</italic>.

Here are a few words from her. I've also scanned in a picture of her party. Tell your boss thanks for letting us keep in touch by email.

Laura
---------- 415ACD5GH889
Content-type: image/gif
Content-transfer-encoding: base64
Content-description: Cutting the cake, sort of

R0lGODdhQAHIKMAAAAAAP+2bQAAAACQAAAAASEgAAAAkSeEgkJG0kJJEkAABIkZFIJCttrZt7Vry4B9aM+yK
omitted...
---------- 415ACD5GH889

9.1.1 Email (SMTP, MIME, IMAP) - Message Transfer

SMTP (Simple Mail Transfer Protocol) is used to transfer messages from one host to another. A mail user agent (mail client or mail reader) connects to a mail daemon or server that speaks SMTP.

Popular server programs that implement SMTP include ______________, postfix and Microsoft Exchange.

SMTP is used to transfer email between hosts.

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A simple SMTP session might look like this:

c: HELO mymachine.com
s: 250 OK
c: MAIL FROM: <tony@gmail.com>
s: 250 OK
c: RCPT TO: <donna@gmail.com>
s: 250 OK
c: DATA
s: 354 Start input, end with <CRLF>,<CRLF>
c: Subject: Hi
c: blah blah blah
c: 
c: s: 250 OK
c: QUIT
In Class Exercise
Telnet to port 25 (SMTP) on csserver. Modify the session on the previous slide to send email to yourself or another user on csserver. You can have multiple RCPT TO: lines to send an email to multiple recipients.
Note: csserver will not relay mail. It will only accept mail for csserver users (all RCPT TO: users must have an account on csserver).

Telnet to port 25 (SMTP) on email.evansville.edu and send an email message to yourself or another user on a different machine.
Note: This server will relay email, but you must authenticate yourself to the server. Instead of “HELO” send “EHLO” and then “AUTH LOGIN”. Then send your base64 encoded acenet userid on one line and your base64 encoded password on the next. (An online base64 encoder is at gtools.com.)

9.1.1 Email (SMTP, MIME, IMAP) - Mail Reader
SMTP is used for sending mail. In days past a user would typically read mail while logged into the same system on which their mailbox existed. It is now more common to access a mailbox remotely. The POP and IMAP protocols are used for this.
A POP or IMAP _______________ must be running on the same system that contains the mailbox.

IMAP is similar to SMTP in many ways. It is a client/server protocol running over TCP. The client issues commands in the form of <CRLF> terminated _________________ text lines.
Typical commands are LOGIN, AUTHENTICATE, SELECT, EXAMINE, FETCH, DELETE, CLOSE, and LOGOUT.
When configuring a mail reader, you must typically specify both a POP or IMAP server for receiving mail and an SMTP server for sending mail (they may be the same).

9.1.2 World Wide Web (HTTP)
A web browser locates an object on the Web using the object's _______________:
http://csserver.evansville.edu/index.html
Your browser uses HTTP (HyperText Transfer Protocol) to send requests to a web server. Like SMTP, HTTP is a text-oriented protocol. Each HTTP message has the form:

START_LINE <CRLF>
MESSAGE_HEADER <CRLF>
<CRLF>
MESSAGE_BODY <CRLF>

Recent versions of HTTP allow for ________________
connections. These requests take the form:
GET /~richardson/ HTTP/1.1
Host: csserver.evansville.edu
<CRLF>

(The Host: line is an example of a MESSAGE_HEADER.)
After receiving the request above the server will leave the connection open (for a few seconds) allowing the browser to send multiple requests on the same connection.
9.1.2 World Wide Web (HTTP) - Response Messages

Response messages also begin with a start message. Example responses are:

HTTP/1.1 202 Accepted

or

HTTP/1.1 404 Not Found

Commonly, the response message will also carry the requested page.

9.1.2 World Wide Web (HTTP) - Uniform Resource Identifiers

A URL is an example of a Uniform Resource Identifier (URI). A URL gives the location of an object on the Web. Examples of other URIs are:

mailto:tony@gmail.com

file:///home/richardson/lecture.html
telnet:csserver.evansville.edu

9.1.2 World Wide Web (HTTP) - TCP Connections

Version 1.1 of HTTP introduced persistent connections. Persistent connections reduce the overhead caused by multiple connection requests, they also allow TCP's ____________ control to operate more efficiently.

A persistent connection may be closed (by either the client or the server) at any time. Both the client and server must monitor the connection to see if it has been closed.

9.1.2 World Wide Web (HTTP) - Caching

Web ____________ store frequently accessed web pages on a local server. Web caches can reduce the response time for client requests and it can reduce traffic on an institution’s access link.

An institutional web cache is often called a proxy server. The browser has to be configured to use the proxy. ISPs may also cache pages, but users are typically unaware that they are retrieving pages from an ISP cache.

HTTP has been designed to support caching. The server assigns an ______________ date to each page and sends the date out in an Expires: header with the page.

A conditional GET (a GET with an If-Modified-Since header) can be used by a cache (or browser) to ensure that the most up-to-date page is returned.

In Class Exercise

Try retrieving web pages from csserver using telnet. Try both non-persistent and persistent GET messages.

The persistent GET may time-out on the server before you can type the second line, so you may want to cut-and- paste your request from a file. You also need to send a blank line at the end of a persistent request.